FINANCIAL RATIO BENCHMARKS FOR DEFENSE INDUSTRY CONTRACTORS

THESIS

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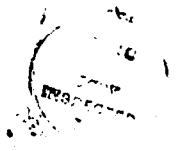

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Abstract

The purpose of this study was to develop and analyze financial ratio benchmarks of the aerospace defense contracting industry. The study addressed four questions: (1) How should the aerospace defense industry be specifically defined? (2) Which financial ratio benchmarks should be provided? What information does a specific ratio provide? (3) How are specific ratio benchmarks calculated and tested for statistical significance? (4) What problems result from financial ratio analysis?

Review of the literature disclosed the capability of defining a specific industry using the Standard Industry Classification System. An industry can be further restricted by only including companies that have recently contracted with the Department of Defense. Based on these restrictions the Compustat data bank was used to access sample data.

From an extensive list of ratios, 14 were selected from 7 main categories: (1) Cash Position, (2) Liquidity, (3) Working Capital/Cash Flow, (4) Capital Structure, (5) Debt Service Coverage, (6) Profitability, and (7) Turnover.

The basic benchmark measurement was defined as the median of the sample observations. Additionally, the central quartile was selected as the measurement of a reasonable range. Assuming the sample is/was representative

of the industry, these measurements provided basic guidelines for all but one of the 14 ratios. The ratio WC/Sales displayed a trend which signified a potential need for adjustment.

Of the problems associated with ratio analysis, the most predominant constraint involves the use of alternative inventory valuation methods. However, prior studies found minimal consequences to company ranking resulted from these inconsistent methods. Still, ratio analysis does not provide a specific guide to action and its usefulness is dependent on the users abilty to interpret its meaning.

FINANCIAL RATIO BENCHMARKS
FOR DEFENSE INDUSTRY CONTRACTORS

I. Introduction

General Issue

Program managers of the United States Air Force Systems Command (AFSC) have the responsibility for periodically analyzing their contractor's financial status. In this regard, the Air Force Institute of Technology's School of Systems and Logistics (AFIT/LS) course, Intermediate Program Management (SYS 400), now includes a recently developed block of instruction on financial analysis techniques. As emphasized in this instruction, an important part of financial analysis is the comparison of a firm's financial ratios with those of the industry norm (10:53). "A ratio, one account divided by another account, is a tool for standardizing financial data" (18:II-6). An industry norm is an average of a ratio for companies within a specific industry. While program managers can be educated regarding the concepts and calculations of financial ratios, their ability to analyze is restricted by the availability of industry norms or "benchmarks" of these financial ratios. Although many published sources provide examples of industry norms, derived norms from a more specific definition of an industry would enhance the framework for evaluating the financial ratio of a firm within this definition. Past

research has provided evidence of significant numerical differences among ratios across industries. These differences are most often explained by "differences in the underlying economic conditions," i.e., "differences in business risk." Consequently, the more specific the industry definition, the more representative are the resulting norms (10:55, 58-62).

This chapter provides an introduction to the research problem and lists the specific questions to be addressed. A discussion on the background examines the Standard Industry Classification System, describes seven categories of financial ratios, and briefly reviews prior research/use of financial analysis with ratio benchmarks.

Specific Problem

AFSC program managers need benchmarks (average financial ratios) of the aerospace defense contracting industry for comparative analysis when evaluating the financial soundness of a contractor.

Research Questions

Addressing the problem above, the questions this research effort will attempt to answer are:

(1) How should the aerospace defense industry be specifically defined?

(2) Which financial ratio benchmarks should be provided? What information does a specific ratio provide?

(3) How are specific financial ratio benchmarks calculated and tested for statistical significance?

(4) What problems result from financial ratio analysis?

Justification

"All procurement contracts by federal agencies, whether invitations for bids or negotiated contracts, require preaward financial surveys" (14:417). The Defense Contract Administration Services (DCAS) makes the majority of the preaward surveys (PAS) (14:418). Their guide, Financial Analysis Training Guide for Preaward and Postaward Financial Analysis, 1978, supports the importance of ratio analysis (9:16-18, App D). It emphasizes the need to continue "financial surveillance of a contractor's financial condition during the period for which contract performance is required" (9:36). Specifically, the financial ratios of a contractor are monitored for their reasonableness with respect to the industry norms. While giving no specific guide to action, the determination of "unreasonable" ratio values highlights potential future problems and the need for further review.

The need to understand the concepts of performing ratio analysis has been recognized by Air Force officials as demonstrated by the instruction provided in the AFIT/LS course, SYS 400. This course provides training to program manager trainees which includes a section on the significance of financial ratio analysis.

To utilize this training, financial ratio norms of aerospace contractors are required for comparison purposes. This research effort is designed to provide these norms or benchmarks, and as well, analyze each type of financial ratio regarding their significance in determining a financial position.

Scope

This research is concerned with specifically defining the aerospace defense industry and providing information on financial ratios. This information will include not only the benefits of financial ratio analysis, but as well, its potential problems and limitations.

Assumptions

1. All major defense industry contractors must file their financial statements with the Securities and Exchange Commission and are included in the Compustat data file.

2. Accounting methods are substantially consistent throughout aerospace defense industry.

Limitations

1. The results of this research only applies to the aerospace industry.

2. The accuracy of the financial ratio benchmarks will be affected by any accounting inconsistencies between contractors.

Background

Defining Aerospace Defense Industry Contractors.

Review of the literature disclosed the capability of classifying industries into groupings with end-product similarity by using the Standard Industry Classification (SIC) system. According to the Statement of Financial Accounting Standards No. 14, "Financial Reporting for Segments of a Business Enterprise," the SIC system classifies business establishments by their type of economic activity (8:1210)--"a set of products which are reasonably homogeneous with respect to end product" (10:54). The Office of Management and Budget has prepared a manual of SIC codes ranging from broad industry divisions at the one-digit level to very specific industries at a four-digit level. As illustrated in Figure 1, business activities are classified into 11 divisions to include the manufacturing division. These divisions are subdivided to a total of 84 two-digit codes. Transportation equipment is one of the subdivisions under manufacturing. At the three-digit level SIC, code 372 identifies the specific industry, aircraft and parts (22:A-4). Finally, at the four-digit level, the industry description is narrowed down to:

1. 3721 Aircraft
2. 3724 Aircraft Engines and Engine Parts
3. 3728 Aircraft Parts and Auxiliary Equipment, Not Elsewhere Classified

(13:13)

Each of these narrow industry descriptions comprises only one in over 1,000 classifications at the SIC four-digit level.

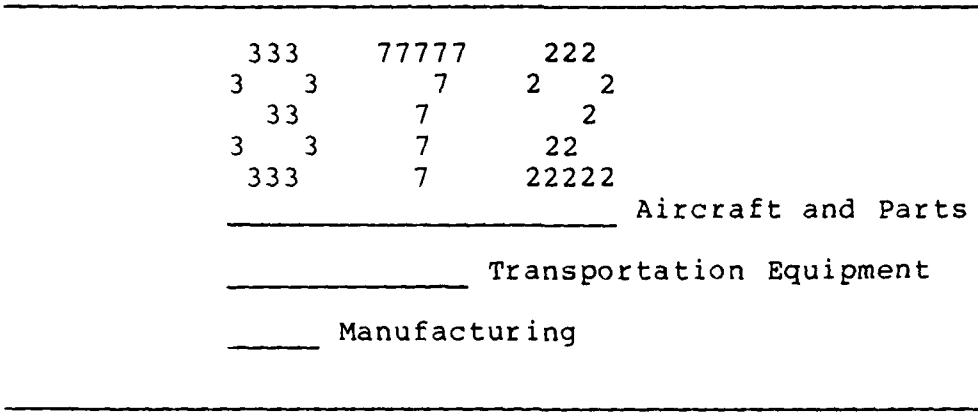


Figure 1. SIC Code 372 Breakout (21:1-3)

Financial Ratios. "Financial ratios are an important tool in analyzing the financial results of a company and in managing a company" (12:19). This statement was a result of a questionnaire sent out in the early 1980s to controllers of the companies listed in Fortune's "Directory of the 500 Largest Industries, 1979." "To be useful, ratios must express significant relationships" (17:758). Through the years literally hundreds of these relationships have been expressed. Based on their inclusion in recently published literature and the availability of data, this research will address multiple financial ratios in seven categories: (1) Cash Position, (2) Liquidity, (3) Working Capital/Cash Flow, (4) Capital Structure, (5) Debt Service Coverage, (6) Profitability, and (7) Turnover (11:60). A description

and the significance of each of these categories follows.

The ratios proposed by this research are meant to be illustrative not exhaustive. Specific ratios with formulas are broken out by category in Table 1 (11:61-68).

1. Cash Position - The pool of funds (cash + marketable securities) that a firm can use to meet its cash obligations. The higher these ratios are, "the higher the cash resources available to the firm" (11:61).

2. Liquidity - Evaluates debt-paying ability of a company by considering not only its ready pool of funds, but as well, additional assets that can potentially be liquidated quickly (7:352, 11:61).

3. Working Capital/Cash Flow - Identifies the cash-generating ability of firms. The higher each of the ratios, the larger the working capital/cash flow, that can be generated (11:62, 64).

4. Capital Structure - Specifies "proportion of assets financed by nonshareholder parties" (11:65). The higher the ratio, the higher the proportion and the decreased means of a firm "to finance assets which earn returns for the owners (2:486).

5. Debt Service Coverage - Indicates company's ability to pay interest payments due to "nonequity suppliers of capital" from current operating income (11:66).

6. Profitability - Associates the amount of resources used with the amount of income earned (i.e., measures efficiency) (2:478). "The higher each of these ratios, the more profitable the firm" (11:67).

7. Turnover - Provides some measure of the liquidity of a firm's inventories. The larger the ratio the faster a firm can expect to liquidate its inventory (7:484).

Problems and Limitations. While "ratios are among the best known and most widely used tools of financial analysis," one must stay aware of their limitations (1:34). The validity of the ratio computations must be evaluated

TABLE 1

Financial Ratio Formulas

Categories	Formulas
1. Cash Position	a. $\frac{\text{Cash + Short-Term Investments}}{\text{Current Liabilities}}$
	b. $\frac{\text{Cash + Short-Term Investments}}{\text{Total Assets}}$
2. Liquidity Position	a. $\frac{\text{Cash + Short-Term Investments + Receivables}}{\text{Current Liabilities}}$
	b. Current Assets / Current Liabilities
3. Working Capital/Cash Flow	a. Working Capital / Sales
	b. Cash Flow / Sales
4. Capital Structure	a. Long-Term Liabilities / Shareholders' Equity
	b. Total Liabilities / Shareholders' Equity
5. Debt Service Coverage	a. Net Income / Interest Expense
	b. Cash Flow / Interest Expense
6. Profitability	a. Net Income / Sales
	b. Net Income / Total Assets
7. Turnover	a. Sales / Total Assets
	b. Cost of Goods Sold (COGS) / Inventory

(11:61-68)

based on the validity and consistencies of the data being computed (1:35). Specifically, any analysis must consider not only the internal operating conditions, but also general business conditions, industry position, management policies, and as well accounting principles. In evaluating ratios, the most predominant constraint involves the potential inconsistencies due to alternative methods of inventory valuation; e.g., First-in First-out (FIFO) versus Last-in First-out (LIFO) (1:105).

On the other hand, "nonuniformity of accounting methods across firms does not necessarily imply noncomparability of financial statement-based ratios" (11:184). Although some research on the LIFO/FIFO inventory alternatives have stressed single instances of large dollar differences, other studies of larger randomly chosen samples had quite different results. Instead, their findings suggested "little differences in the ranking of firms if either inventory valuation method is consistently used" (5:225; 10:187). Furthermore, while there are adjustment techniques available, there presently is "limited evidence on the accuracy of these techniques" (10:192). Finally, there is the option available of not making any adjustment. This option is based on "the assumption that the change is immaterial or that the change is an appropriate response by management to (say) a shift in the underlying business enviroment" (11:215).

Methods of Financial Analysis with Ratios. Extensive empirical research concerning the financial state of a firm has resulted in several methods of financial analysis with ratio comparisons to include: (1) Beaver's Univariate Model, (2) Altman's Z-Score Model, (3) The Zavgren Model, (4) The Financial Capability (FINCAP) Analysis Method, and (5) Robert Morris Associates Statement Studies. A brief summary of each of these methods follows:

1. Beaver's Univariate Model. Published in 1966 in the Journal of Accounting Research, the article, "Financial Ratios as Predictors of Failure" by W. Beaver described a discriminant analysis technique that used a univariate approach. His concept of ratio analysis, a cash flow model, viewed each firm as a "resevoir of liquid assets, which is supplied by inflows and drained by outflows" (23:3). Through individual analysis of 30 ratios, 6 were chosen as the "best in classifying firms as failed or not failed:" (1) Cash flow to total debt, (2) Net income to total assets, (3) Working capital to total assets, (4) Total debt to total assets, (5) Current ratio, and (6) The no-credit interval (23:8). To choose these 6, Beaver performed a dichotomous classification test on a sample of 79 failed and 79 non-failed firms. This test first ranks each firm by the value of a specific ratio. Then an "optimal" cutoff point for predicting bankruptcy is determined by visually inspecting the ranked ratios and choosing the value which "minimized

the total misclassification percentage" (11:542-543). Despite limitations of statistical design, Beaver's study obtained "a fairly high predictive ability with a simple model" (23:9). Difficulties with his model include restriction to the 30 original ratios based on their popularity in literature. More important ratios may have been eliminated. Additionally, due to techniques designed to alter ratio values, "the predictive ability of popular ratios may be unreliable" (23:9). More importantly, Beaver's univariate approach is limited in that different ratios are used to classify firms individually, and the potential exists for a firm to receive conflicting classifications (23:10). Since no single ratio has been able to capture the multidimensions of a firm's financial status, several authors have published research using multiple discriminate analysis. One of the more popular models follows.

2. Altman's Z-Score Model. In 1968, E. Altman published in The Journal of Finance his article titled "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy." He researched the use of modern statistical techniques with regards to ratio analysis. Using a discriminate analysis technique, Altman attempted to demonstrate that a multivariate approach could improve bankruptcy prediction and be useful in practical applications (23:15).

Evaluating data from a sample of 33 bankrupt and 33 non-bankrupt firms, a discriminant function was selected containing 5 of the original 22 variables Altman selected. "Those selected did not include variables that would have been considered the best predictors if evaluated on an individual basis" (23:16). The function selected was:

$$Z = .021 * X1 + .041 * X2 + .033 * X3 + .006 * X4 + .999 * X5 \quad (1)$$

where:

X1 = working capital/total assets,
X2 = retained earnings/total assets,
X3 = earnings before interest and taxes/total assets,
X4 = market value equity/book value of total debt,
X5 = sales/total assets, and
Z = overall index.

Altman's model was significant as the first to evaluate the ability of combining several ratios to assess a firm's financial well-being. Still, the problem remained of restriction of the original 22 ratios to a judgmental selection. Table 2 illustrates that Altman achieved higher accuracy than Beaver, especially for the first year prior to bankruptcy (23:4). Given a longer time interval though, Altman's predictive accuracy decreased drastically, while Beaver continued to reasonably predict even five years prior to failure.

TABLE 2

Misclassification Rates of
Representative Bankruptcy Prediction Studies

Years Prior to Failure	Rates	
	Beaver	Altman
1	10%	5%
2	18%	18%
3	21%	52%
4	24%	71%
5	22%	64%

(23:4)

3. The Zavgren Model. In 1982 while attending Purdue University, Christine Zavgren published a working paper titled "An Analysis of the Relationship between Failure Likelihood and Certain Financial Variables for American Industrial Firms." Her focus differed from that of previous studies is that her main purpose was "to estimate a model to provide a measure of the probability of failure" (23:28). Using a conditional probability technique versus the discriminate analysis technique used by Beaver and Altman, Zavgren derived coefficients of seven "independent" variables. The seven variables (ratios) each represent an important functional dimension that had previously been reported as relatively stable (6:64-65; 23:28). These ratios, their method of calculation, and their respective Zavgren model coefficients are provided in Table 3 (6:65).

These coefficients were applied to their corresponding ratios to indvidually evaluate sample firms. Further manipulation (to be detailed in Chapter 2) resulted in a

TABLE 3

Zavgren Model Variables and Coefficients

Ratio	Calculation	Coefficient
Inventory Turnover	Avg Inv/Sales	.00108
Receivables Turnover	Avg Rec/Avg Inv	.01583
Cash Position	(Cash + Marketable Securities)/Total Assets	.10780
Short-Term Liquidity	(Cash + Marketable Securities)/Current Liabilities	-.03074
Return on Investment	Income/(LT Debt + SH Equity)	-.00486
Financial Leverage	LT Debt/(LT Debt + SH Equity)	.04350
Capital Turnover	Sales/(Total Assets - Current Liabilities)	-.00110

(6:65)

measure of a firm's propensity to fail" (23:25). As in the previously mentioned studies, the choice of ratios used was "based on prior empirical evidence." Further analysis of an expanded variable set was recommended (23:30).

4. The FINCAP Analysis Method. Published in 1979, FINCAP Analysis describes a method used by AFSC contracting personnel in the late 1970s through early 1980s to evaluate the financial capability of major Air Force contractors (18:1-1). An integral part of the FINCAP Analysis method was the Contractor Financial Data and Analysis System

(FINANDAS) (18:2-10). FINANDAS was a timesharing computer program which incorporated a data bank containing five years of historical data on selected companies. Data were compiled from COMPUSTAT, DOD data, and prospective contractor-supplied data (14:418). It had the capability to calculate ratios and trends, and project future financial data. Specifically, FINANDAS computed 22 individual ratios in 5 different classifications: (1) Performance, (2) Capitalization, (3) Liquidity, (4) Coverage, and (5) Facilities (18:II-6-10). Additionally, the FINANDAS system was designed to automatically calculate and present Altman's Z-score as previously described (18:II-10-11).

5. Robert Morris Associates (RMA) Statement Studies. Annually, RMA publishes statement studies based on data voluntarily submitted from its member banks. These studies contain ratio "guidelines" categorized by SIC code. They are presented as "guidelines" versus absolute industry norms due to their nonrandom selection. There are three values calculated for each ratio: the median and the upper and lower quartiles (19:7). They are derived by listing the values per company of each ratio in an order from the strongest to the weakest. These arrays of ratio values are then "divided into four groups of equal size" (19:7). The median is the mid-point while the upper and lower quartile points split the upper half and lower half (see Figure 2) (19:7). RMA includes 16 different ratios under 5 principal

categories: liquidity, coverage, leverage, operating, and specific expense items (12:8). Six of these ratios (current, quick, COGS/Inventory, Sales/WC, Income/Interest Expense, and Sales/Total Assets) will be compared with the findings of this study in Chapter 3.

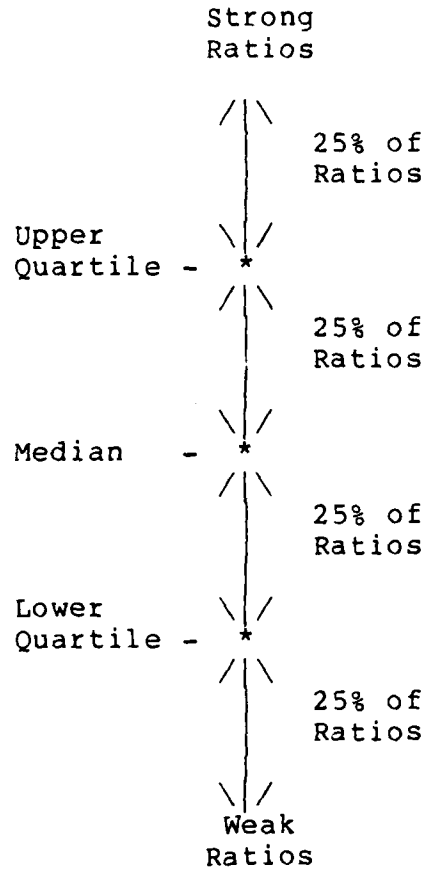


Figure 2. Quartile Illustration
(Printed with permission of RMA) (19:7)

Summary

This chapter identified the need for financial ratio benchmarks for the aerospace industry as the specific effort of this thesis. It introduced four research questions and

then, through a review of the literature, answered the first two by (1) defining the aerospace industry using the SIC system, and (2) specifying the fourteen ratio benchmarks to be provided and the information given by each. The fourth question was addressed in the section on problems and limitations. The chapter concluded by summarizing several examples of past research and actual use of financial analysis with ratio comparisons.

Utilizing some of the statistical techniques derived from reviewing the literature, the next chapter details the methodology used to address the research question concerning both how ratio benchmarks are calculated and how to test their statistical significance.

II. Methodology

Overview

The previous chapter provided an introduction to the research problem (i.e., the need for aerospace contractor financial ratio benchmarks). It provided a review of the relevant literature pertaining to definition of an industry, and discussion of financial ratio categories and various analysis methods.

The purpose of this chapter is to describe the research techniques to be used to answer the third research question. The objective is to determine statistically significant financial ratio benchmarks for evaluation of aeronautical defense contractors. The general methods will focus on manipulation and extraction of financial ratio data from the Standard and Poors' computerized data file, Compustat, and statistical analysis of the significance of the derived benchmarks.

Defining the Industry

As stated in Chapter 1, the Standard Industrial Classification (SIC) of industries is consistent with the definition for end-product of an industry. For this research, the three-digit SIC code 372 will be used to define the aerospace industry.

Calculating Benchmarks

Financial ratio benchmarks will be calculated using the data file, Compustat. The capabilities of a computer based data file allow one to store, access, sift and manipulate data mathematically, and could accomplish almost instantly what could very well require weeks of manual input (1:43). Compustat, a service of Standard and Poors' Corporation, available at the University of Dayton in Dayton, Ohio, will be used to accomplish this research. The Statistical Analysis System (SAS) program produced to accomplish this effort is included in Appendix A.

A benchmark or average can be measured by several statistics (11:105). Most commonly they are measured as the mean or the median. The mean is calculated as the sum of the values divided by the number of values. The median is computed by first ranking the observations from highest to lowest, and then choosing the ratio in the middle. For an even number of observations, the median is calculated as the mean of the middle pair (16:12). Although this research will present the mean values, it will concentrate on the median as the industry norm. Reasons for this decision stem from the median statistic's ability "to eliminate the influence which values in an 'unusual' statement would have on an average" (19:7).

Defining the Population

The population of contractors included in the research will be restricted by the availability of SIC code 372 companies included in the Compustat data file. Additionally, the research will only include companies which have contracted with the Aeronautical Systems Division (ASD) since 1980. Data extraction will include multiple ratios per company per year for the past decade (1978-1987).

Statistical Analysis

Standard Deviation. Although a midpoint or "norm" of a distribution may be something to aim for, a reasonable range of dispersion is to be expected. The standard deviation statistic is one of the most common for measuring this characteristic of data distribution. The standard deviation is typically used to compare the dispersion in populations with similar mean values. But it can also be used to "estimate the percentage of population members that lie within a specified distance of the mean" (16:19). For many large populations with normal distributions, the "rule of thumb" is about 68% of the values lie within one standard deviation of the mean, and approximately 95% lie within two standard deviations (16:20). Additional research promotes the expectation that less than 1/9 of a population will fall outside three deviations from the mean (10:170). Chapter 3 will evaluate each of the 14 ratios in regards to their compliance with these expectations.

High Quartile - Low Quartile Range. As discussed in Chapter 1, a common determination of a reasonable range for a ratio are the central "quartiles" or middle 50% of a population, thus eliminating the "unusual" values (19:7). Many, perhaps most, ratios are expected to have nonnormal distributions greatly reducing the significance of the standard deviation--a statistic which assumes a normal distribution (11:102). Many ratios have the technical lower limit of zero; others have a top limit of one or are just naturally skewed. By examining the "fractiles or percentiles of the distribution rather than focusing only on the mean and standard deviation," a more accurate range of ratio values should be reflected (11:104; 19:7). Chapter 3 will present the point values of the high and low quartiles. Analysis will include determination of whether the inner quartiles fall within a single standard deviation from the medians.

Other Measures of Dispersion. Due to their current growing popularity in the literature, two other measures of dispersion will be presented and analyzed: (1) the variability measure and (2) the studentized range.

Variability Measure. The objective of the variability measure is to "expand beyond one fiscal year the information contained in a single ratio measure" (11:72). It is simply calculated as:

$$\frac{\text{Maximum Value - Minimum Value}}{\text{Mean Financial Value}} \qquad (2)$$

Studentized Range (SR). The SR statistic "tends to be 'large' for fat-tailed distributions" (11:107). It is calculated as:

$$\frac{\text{Maximum Value - Minimum Value}}{\text{Standard Deviation}} \qquad (3)$$

With observations exceeding 100, the published rule of thumb for suspecting distributions to have fat tails is an SR value greater than 6.5 (11:107).

Cross-Section Correlation. A cross-sectional analysis is used to "examine the correlation between financial ratios of firms at a point in time" (11:114). This correlation is extremely important when combining financial ratios to create a single measurement of a firm's financial health. High correlation (multicollinearity) between variables of a model results in model coefficients which may be very sensitive to sample size changes. Due to the previously mentioned "non-normal" distributions of many ratios, the Spearman rank correlation (a statistic that does not assume normality) was chosen to test the correlation of this study's 14 ratios (11:114). Calculation of the Spearman rank correlation coefficient first requires a ranking of observation (company) values for each ratio from strongest to weakest. Ratios rankings are paired one at a time, differences of the two ratio rankings per company are calculated and then squared. The Spearman rank correlation coefficient is then calculated as:

1 - ((6 * sum of squared difference)/(N cubed - N)) (4)

where N is the number of observations (companies).

Time-Series Trends. Comparable ratio values of earlier fiscal periods should be carefully studied to determine trends. Any significant trend should be given consideration with the effect of the trend incorporated into the benchmark determination. Approaches to this analysis include (1) visually examining the data and (2) using statistical tools to detect significant systematic patterns in the data (11:218). To enhance a visual examination, Appendix B will include graphs illustrating the trend of the yearly medians per ratio. Additionally, these medians will be statistically evaluated using (1) the autocorrelation function and (2) performing linear regression.

1. Calculating the Autocorrelation Coefficient. This coefficient is estimated as (11:32):

$$\frac{\text{Sum of } ((Xt) - \bar{X})((X(t+j)) - \bar{X})}{\text{variance}} \qquad (5)$$

where

$\bar{X}$ designates the "mean" of the observations

Xt designates the observation being calculated; t ranges in value from 1 to T-j

T designates the total number of observations

j designates the lag of time between specified observations (for this research, j = 1)

Theoretically, for a population with truly random changes, this coefficient would equal zero (11:232). In actuality, one cannot expect estimated autocorrelation coefficients to be exactly zero. Instead, as a "general rule of thumb", a coefficient can be determined "significantly different from zero if the sample estimate is more than two standard errors from zero" (11:233). The standard error (SE) equals:

$$SE = \text{square root of } (1/(T - j)) \quad (6)$$

with T = 10 years, and j = 1:

$$SE = \text{square root of } 1/9 = 1/3. \quad (7)$$

Thus, for this sample to be significant, a coefficient value must either exceed +.666 or be less than -.666.

2. Testing with Linear Regression. Due to its ability to determine the existence of a relationship between two or more quantitative variables, this study also will include regression analysis to evaluate potential time-series trends (15:23). Separately, each financial ratio yearly median (the dependent variables) will be compared with the independent variable "year." The study's regression model will be:

$$\text{Financial Ratio Yearly Median} = a + b(\text{year}) + e \quad (8)$$

where

a = the Y intercept

b = the slope fo the regression line

e = the random error term

Based on the 10 years/observations, a line of best fit is computed using a SAS program. Additional statistics including a "T" value are generated as requested. The "T" value equals the slope of the line divided by the estimated standard error of the slope. This statistical value tests whether the slope of the fitted line is significantly greater than or less than zero. A significant slope would demonstrate an upward or downward trend in a financial ratio median between 1978 and 1987. To test the "T" values calculated by SAS, specific research bypothesis and decision rule are as follows:

Null and Alternative Hypothesis: H_o: $b = 0$ (no trend)

H_a: $b \neq 0$ (trend)

Decision Rule: If the absolute value of "T" calculated is greater than "T" critical, reject H_o; otherwise fail to reject H_o (i.e., if b=0, then the ratio median of a representative population sample is a "good" benchmark).

The "T" critical value is based on the significance required and whether the test is one-tailed or two-tailed. Since this research looks for both upward and downward trends, the test is two-tailed. Due to its frequent use in "classical hypothesis testing," a significance level of 0.05 will be used (13:265). Thus, based on these factors and with eight degrees of freedom (ten observations less two parameter estimates), the "T" critical value is 2.306 (15:518).

Zavgren's Model. As presented in Chapter 1, an index representing the probability of a company's impending failure can be derived by computing the Zavgren model with company specific data. Each of the seven ratios are calculated, and multiplied by both 100 and its respective coefficient. The seven products are summed and the total is added to -.23883. This result, designated as 'y' is then manipulated as follows (6:64):

$$\text{Probability Index} = 1/(1 + e^{-y}) \qquad (9)$$

where

e is the base of natural logarithms.

The calculation of this model will be included as a statistical analysis technique to examine the "financial soundness" of the companies within the sample.

Summary

Chapter 2 presented the details of the main research effort, and actual calculation and statistical analysis of the financial ratio norms. It explained how the sample data was determined; and furthermore, how the Compustat data file was accessed, data extracted, and finally manipulated into ratios (see SAS program in Appendix A). In conclusion, this chapter laid the general framework for testing the statistical significance of each benchmark.

Explicitly, the statistical definition of a benchmark is the median ratio value of companies within a specific

industry. The inner quartile surrounding the median presents an acceptable range of ratio values. To be considered useful/significant, this range should come from distributions which resemble normal in regards to a tightness of values around the median. Additionally, consideration of benchmark adjustment should be made for any ratio distribution exhibiting a definite time-series trend. Finally, although correlation between ratios doesn't affect their significance when analyzed individually, these relationships prove extremely important when combining ratios to formulate a single index.

The next chapter contains the results of the data extraction and manipulation into ratios. Overall medians, low quartiles and high quartiles will be calculated and displayed. Finally, results of statistical tests will be presented and level of significance discussed.

III. Data Analysis and Findings

Introduction

The previous chapter described the methodology used to compute financial ratio norms and techniques to test their statistical significance. This chapter presents the findings derived from the data and statistical analysis. The first section describes the population sample members that resulted from the restrictions detailed in Chapter 2. The next section presents the derived "benchmarks" and their respective inner quartile range points. The chapter concludes with the results of several statistical analysis techniques/tests outlined in Chapter 2.

Population Sample Description

A visual comparison of an ASD listing of contractors utilized since 1980 and the listing of companies provided by Compustat per the user manual, provided an original sample set of 14 contractors. Due to circumstances surrounding two of these companies (one had less than 10 years of data, and one produced bad results due to denominator values of zero), the list of companies was reduced to 12. These defense aerospace industry contractors are as follows:

1. Allied Signal Corporation
2. Boeing Company, Incorporated
3. General Dynamic Corporation
4. Grumman Corporation
5. McDonnell Douglas Corporation
6. Northrop Corporation
7. Raven Industries Incorporated

8. Rockwell International Corporation
9. Sunstrand Corporation
10. Teledyne Incorporated
11. United Technologies Corporation
12. Whittaker Corporation

To enhance visual display of firm comparison per ratio, these contractors are also ranked by current (1987) total asset size in Table 4.

TABLE 4

Companies Ranked by Size

	Company	1987 Total Assets ($B)
1.	Boeing Company, Incorporated	12.566
2.	United Technologies Corporation	11.928
3.	Allied Signal Corporporation	10.226
4.	Rockwell International Corporation	8.739
5.	McDonnel Douglas Corporation	8.536
6.	General Dynamics Corporation	5.032
7.	Teledyne Incorporated	3.135
8.	Northrop Corporation	3.124
9.	Grumman Corporation	2.254
10.	Sunstrand Corporation	1.480
11.	Whittaker Corporation	.430
12.	Raven Industries Incorporated	.163

Calculated Benchmarks/Quartile Range

A benchmark for each of the 14 ratios was calculated by first accessing through Compustat the required financial statement values per company through 10 years (1978 - 1987). A SAS program (Appendix A) performed the raw data extraction and as well calculated the ratio values requested. To facilitate graphing/worksheet analysis, the raw data were re-input into a Quattro computer program. For each of the 14 different ratios, the 120 observations were ranked by value, and their middle pairs were each totaled and divided by two. These values (the medians), and the upper and lower quartile points are exhibited in Table 5. The mean is also presented for comparison purposes. Additionally, a comparison with six corresponding ratios presented annually for SIC Code 372 (aircraft and aircraft parts manufacturers to include non-DOD as well as DOD contractors) by RMA is shown in Table 6 (19:186).

Beyond an overall benchmark, separate medians were calculated both by company and by year. These median values are presented in Tables 7 and 8, and as well, their values are graphically illustrated in Appendix B. Note the company numbers assigned in Appendix B correspond to the listing of companies by current total asset size (see Table 4).

Additional Statistical Results

Standard Deviation. The standard deviations of the ratios measured by this research are presented in Table 9.

TABLE 5

Medians/Means/Quartile Points

	C+ST INV/ CUR LIAB	C+ST INV/ T ASSETS	QUICK RATIO	CURRENT RATIO	WC/ SALES	C FLOW/ SALES	LT LIAB/ SH EQUITY
MEDIAN	0.163	0.061	0.845	1.518	0.115	0.067	0.245
MEAN	0.263	0.087	0.900	1.731	0.126	0.073	0.246
LO QUARTILE	0.057	0.019	0.590	1.289	0.037	0.053	0.361
HI QUARTILE	0.340	0.133	1.086	2.087	0.204	0.089	0.069

	T LIAB/ SH EQUITY	INC/ INT EXP	C FLOW/ INT EXP	INC/ SALES	INC/ T ASSETS	SALES/ T ASSETS	COGS/ INVENT
MEDIAN	1.055	4.074	6.882	0.041	0.061	1.565	4.352
MEAN	1.066	8.516	12.843	0.044	0.065	1.528	6.416
LO QUARTILE	1.372	1.901	3.748	0.031	0.045	1.237	3.162
HI QUARTILE	0.724	9.792	15.446	0.052	0.081	1.793	7.505

TABLE 6

Comparison with RMA Benchmark Calculations

	Quick Ratio		Current Ratio		WC/Sales	
	This Research	1988 RMA	This Research	1988 RMA	This Research	1988 RMA
Hi Quartile	1.1	1.7	2.1	3.2	.2	.3
Median	.8	.8	1.5	1.9	.1	.2
Lo Quartile	.6	.5	1.3	1.4	.Ø	.1

	Income/Int Exp		Sales/T Assets		COGS/Inventory	
	This Research	1988 RMA	This Research	1988 RMA	This Research	1988 RMA
Hi Quartile	9.8	1Ø.1	1.8	2.2	7.5	6.2
Median	4.Ø	4.3	1.6	1.7	4.4	4.1
Lo Quartile	1.9	1.8	1.2	1.2	3.2	2.5

(19:186)

TABLE 7

Median Values by Company

COMPANY	C+ST INV/ CUR LIAB	C+ST INV/ T ASSETS	QUICK RATIO	CURRENT RATIO	WC/ SALES	C FLOW/ SALES	LT LIAB/ SH EQUIT
BOEING	0.501	0.273	0.749	1.497	0.170	0.074	0.054
UNITED T	0.064	0.025	0.594	1.545	0.115	0.056	0.258
ALLIED S	0.102	0.029	0.704	1.302	0.011	0.092	0.362
ROCKWELL	0.325	0.160	0.856	1.315	0.090	0.073	0.181
McD DOUG	0.019	0.010	0.323	1.145	0.050	0.057	0.057
GEN DYN	0.083	0.035	1.132	1.430	0.067	0.065	0.029
TELEDYNE	0.610	0.110	1.512	2.067	0.125	0.146	0.298
NORTHROP	0.113	0.065	0.408	0.728	0.040	0.045	0.021
GRUMMAN	0.234	0.063	1.091	2.280	0.215	0.043	0.478
SUNSTRAND	0.040	0.009	0.792	2.486	0.312	0.118	0.314
WHITTAKER	0.184	0.079	0.821	1.568	0.093	0.049	0.388
RAVEN IND	0.300	0.082	1.446	2.899	0.304	0.071	0.300

COMPANY	T LIAB/ SH EQUITY	INC/ INT EXP	C FLOW/ INT EXP	INC/ SALES	INC/ T ASSETS	SALES/ T ASSETS	COGS/ INVENT
BOEING	1.105	23.245	39.111	0.045	0.065	1.476	3.748
UNITED T	1.072	1.905	3.406	0.035	0.056	1.593	3.312
ALLIED S	0.923	1.832	3.881	0.045	0.052	1.067	5.479
ROCKWELL	1.185	6.052	10.281	0.046	0.070	1.547	6.149
McD DOUG	1.611	6.648	12.854	0.030	0.047	1.570	2.602
GEN DYN	0.690	7.707	12.909	0.041	0.082	1.989	19.101
TELEDYNE	0.543	15.681	19.214	0.117	0.139	1.162	12.686
NORTHROP	1.389	9.452	12.148	0.037	0.066	1.911	7.830
GRUMMAN	1.104	1.351	2.530	0.020	0.038	1.879	4.206
SUNSTRAND	0.695	2.666	4.586	0.066	0.066	1.008	1.844
WHITTAKER	1.551	3.782	5.166	0.033	0.054	1.646	4.481
RAVEN IND	0.719	3.331	5.834	0.041	0.076	1.762	3.658

TABLE 8

Median Values by Year

YEAR	C+ST INV/ CUR LIAB	C+ST INV/ T ASSETS	QUICK RATIO	CURRENT RATIO	WC/ SALES	C FLOW/ SALES	LT LIAB/ SH EQUITY
1978	0.211	0.076	0.902	1.649	0.030	0.059	0.355
1979	0.148	0.060	0.825	1.506	0.116	0.072	0.282
1980	0.172	0.052	0.821	1.469	0.102	0.064	0.312
1981	0.229	0.069	0.857	1.574	0.121	0.057	0.241
1982	0.153	0.065	0.801	1.477	0.114	0.059	0.179
1983	0.180	0.078	0.942	1.538	0.123	0.065	0.142
1984	0.201	0.066	0.804	1.581	0.122	0.076	0.218
1985	0.175	0.063	0.849	1.648	0.166	0.069	0.240
1986	0.076	0.033	0.786	1.379	0.125	0.066	0.297
1987	0.096	0.035	0.742	1.379	0.123	0.074	0.258

YEAR	T LIAB/ SH EQUITY	INC/ INT EXP	C FLOW/ INT EXP	INC/ SALES	INC/ T ASSETS	SALES/ T ASSETS	COGS/ INVENT
1978	1.226	3.248	5.243	0.038	0.058	1.586	5.450
1979	1.317	3.865	5.469	0.045	0.076	1.529	4.164
1980	1.062	4.880	7.048	0.041	0.067	1.574	3.735
1981	1.022	3.363	6.495	0.038	0.061	1.638	3.969
1982	0.869	3.467	6.448	0.035	0.059	1.609	4.353
1983	0.893	6.878	8.516	0.043	0.061	1.664	4.886
1984	1.015	5.748	9.833	0.047	0.080	1.617	5.044
1985	0.876	4.913	9.773	0.042	0.061	1.510	4.581
1986	1.144	1.742	4.207	0.027	0.038	1.536	4.512
1987	1.183	2.149	6.652	0.033	0.044	1.413	4.053

TABLE 9

Standard Deviation Statistics

	C+ST INV/ CUR LIAB	C+ST INV/ T ASSETS	QUICK RATIO	CURRENT RATIO	WC/ SALES	C FLOW/ SALES	LT LIAB/ SH EQUITY
STD DEV	0.327	0.096	0.478	0.745	0.115	0.035	0.193
MEAN+STD	0.590	0.182	1.378	2.476	0.240	0.108	0.439
MEAN-STD	-0.064	-0.009	0.422	0.986	0.011	0.037	0.054
COUNT > 1 STD	15	18	30	30	49	30	42
MEAN+(2*STD)	0.917	0.278	1.856	3.221	0.355	0.144	0.632
MEAN-(2*STD)	-0.391	-0.105	-0.056	0.241	-0.104	0.002	-0.139
COUNT > 2 STD	5	5	5	9	3	7	7
MEAN+(3*STD)	1.244	0.374	2.334	3.966	0.470	0.179	0.825
MEAN-(3*STD)	-0.718	-0.201	-0.534	-0.504	-0.218	-0.034	-0.332
COUNT > 3 STD	2	3	2	1	0	2	0

	T LIAB/ SH EQUITY	INC/ INT EXP	C FLOW/ INT EXP	INC/ SALES	INC/ T ASSETS	SALES/ T ASSETS	COGS/ INVENT
STD DEV	0.387	11.601	15.730	0.030	0.037	0.396	5.942
MEAN+STD	1.453	20.117	28.572	0.075	0.102	1.924	12.358
MEAN-STD	0.679	- 3.086	- 2.887	0.014	0.028	1.131	0.474
COUNT > 1 STD	45	16	15	23	23	34	14
MEAN+(2*STD)	1.840	31.719	44.302	0.105	0.139	2.320	18.300
MEAN-(2*STD)	0.292	-14.687	-18.616	-0.016	-0.010	0.735	- 5.468
COUNT > 2 STD	2	4	6	7	8	6	7
MEAN+(3*STD)	2.227	43.320	60.031	0.135	0.176	2.716	24.242
MEAN-(3*STD)	-0.095	-26.288	-34.346	-0.046	-0.047	0.339	-11.410
COUNT > 3 STD	0	3	3	3	3	0	3

Additionally, this table reflects the results of analyzing the normality of the distributions based on the count of observations which fall outside the mean "+" or "-" either one, two, or three standard deviations. As described in Chapter 2, the "rule of thumb" for distributions of large populations is about 68% of the observations lie within one standard deviation while 95% lie within two. For this somewhat large population of 120, this means only 38 of the observations may fall outside one standard deviation, and just 6 may fall outside two standard deviations. Three of the ratios (WC/Sales, Lt Liab/SH Equity, and T Liab/SH Equity) did not pass the one standard deviation test while six of the ratios failed the two standard deviation test. The additional published expectation that less than 1/9 of the observations (in this case 13) fall outside of three standard deviations is much more lenient and easily met.

Further analysis of the reasonableness of the inner quartile range as compared with the standard deviation demonstrated the high and low quartile points easily fell within one standard deviation from the median for all ratios.

Variability Measure/Studentized Range. The two additional measures of dispersion gave somewhat conflicting results (Table 10). Visual inspection of the variability measure (Figure 3) illustrates a substantially higher variability exists for two ratio categories, Cash Position and Debt Service Coverage. The Liquidity Ratios and Capital Structure Ratios demonstrated the lowest variability.

TABLE 10

Additional Measures of Dispersion

Ratios	Variability Measures	Studentized Range
C+ST INV/CUR LIAB	7.797	6.269
C+ST INV/T ASSETS	5.954	5.388
QUICK RATIO	3.113	5.863
CURRENT RATIO	2.339	5.434
WC/SALES	3.813	4.178
C FLOW/SALES	2.754	5.633
LT LIAB/SH EQUITY	3.285	4.200
T LIAB/SH EQUITY	1.494	4.116
INC/INT EXP	8.139	5.974
C FLOW/INT EXP	6.709	5.477
INC/SALES	4.461	6.570
INC/T ASSETS	3.595	6.256
SALES/T ASSETS	1.262	4.865
COGS/INVENT	5.224	5.641

VARIABILITY MEASURE

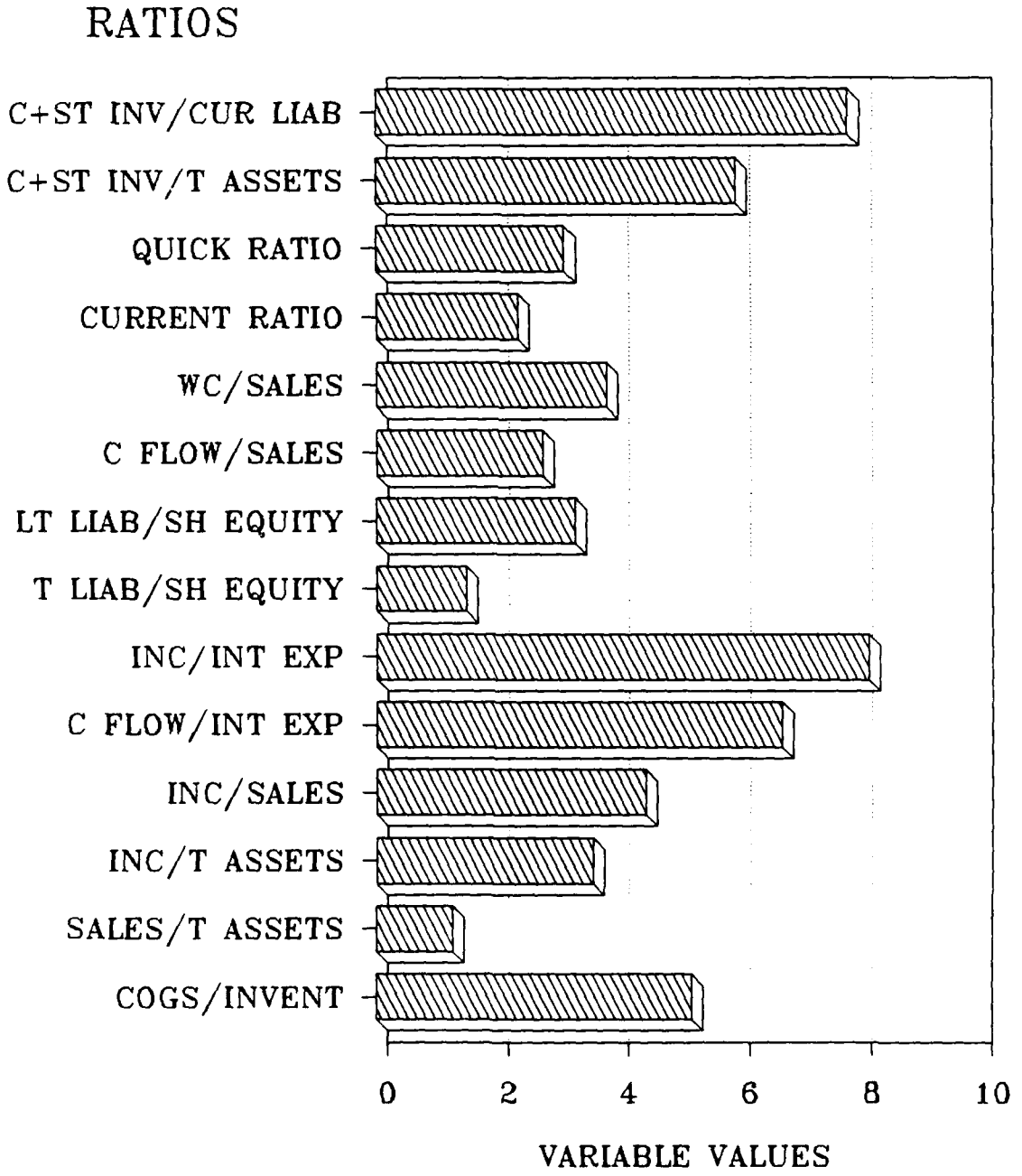


Figure 3. Graph of Variability Measure

On the other hand, Figure 4 illustrates a fairly tight spread of Studentized Range results, between 4.116 and 6.57. Although half of the ratios exceeded 5.5, only one, the net income to sales ratio, exceeded the published rule of thumb, 6.5. Thus, at least to some extent, the distribution for ratio #11 can be suspected to have "fat tails." Interesting to note was that these results demonstrated matching results (fat tail distributions versus normal) within five of the seven categories, i.e., most categories had one ratio with a studentized range measure above 5.5 and one below. Significantly, the Capital Structure category reflected the two lowest measures, while the Profitability category had the highest and the third to highest measures.

Cross-Section Correlation. Per the Spearman rank correlation analysis (SR) technique as described in Chapter 2, a ranking of companies by company median ratio strength was formulated (Table 11). Further calculation of the SR technique provided coefficients as presented in Table 12.

Of these 91 coefficients, four sets of ratios demonstrated extremely high correlation--exceeded a positive .9. While these four included two sets from the same categories, Cash Position and Debt Service Coverage; they also included two sets which crossed categories, ratios 4 to 5 and ratios 6 to 11.

STUDENTIZED RANGE

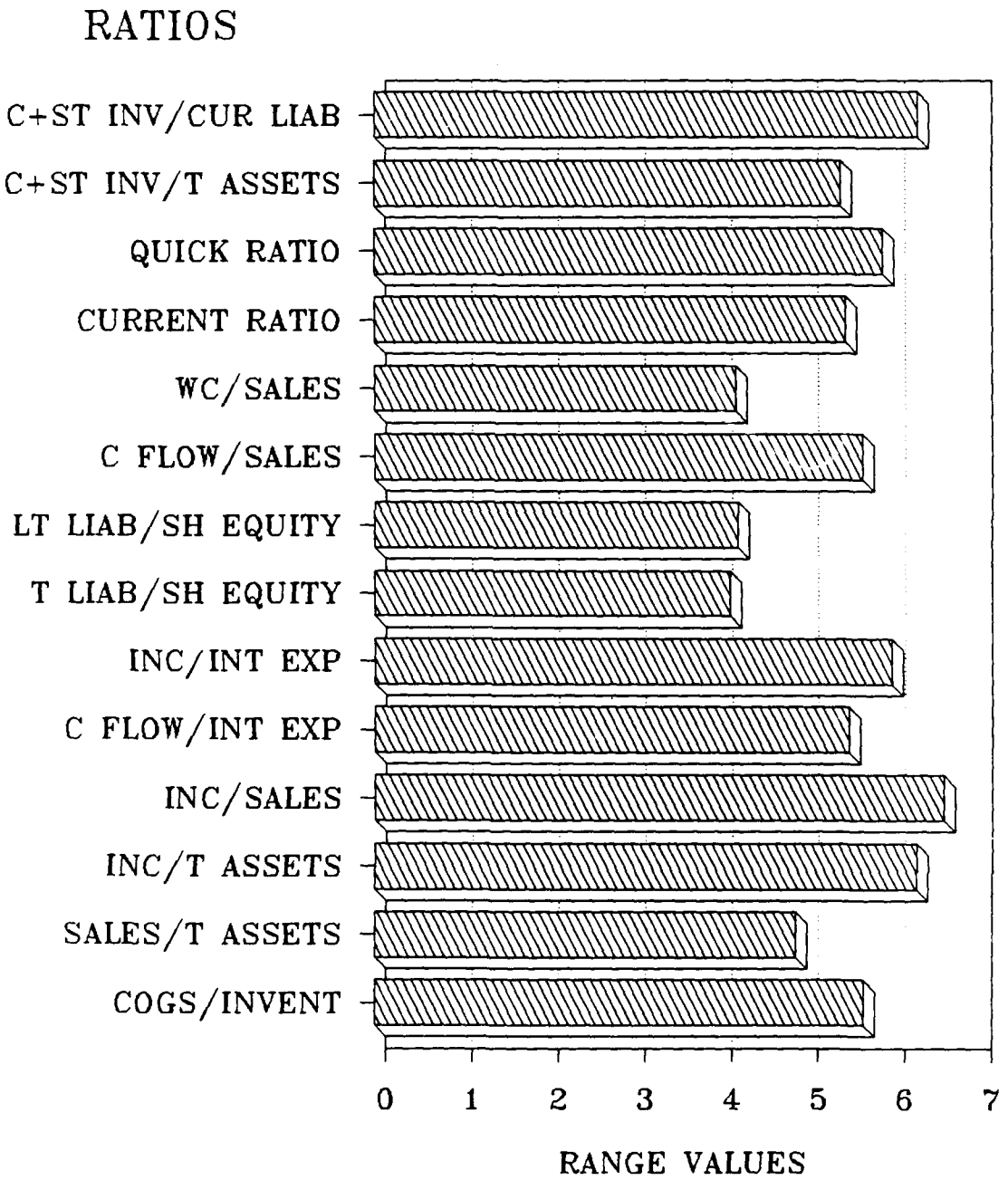


Figure 4. Graph of Studentized Range

TABLE 11

Company Ranking by Ratio Strength

RATIOS:	1	2	3	4	5	6	7	8	9	10	11	12	13	14
COMPANIES	RANKING													
Boeing	2	1	8	7	4	4	4	8	1	1	4	7	9	9
United T	10	10	10	6	6	9	6	6	10	11	9	8	6	10
Allied S	8	9	9	10	11	3	10	5	11	10	5	10	11	5
Rockwell	3	2	5	9	8	5	5	9	6	6	3	4	8	4
McD Doug	12	11	12	11	10	8	3	11	5	3	11	11	7	11
Gen Dyn	9	8	3	8	9	7	2	2	4	4	7	3	1	1
Teledyne	1	3	1	4	5	1	7	1	2	2	1	1	10	2
Northrop	7	6	11	12	12	11	1	10	3	5	8	5	2	3
Grumman	5	7	4	3	3	12	12	7	12	12	12	12	3	7
Sunstrand	11	12	7	2	1	2	9	3	9	9	2	6	12	12
Whittaker	6	5	6	5	7	10	11	12	7	8	10	9	5	6
Raven Ind	4	4	2	1	2	6	8	4	8	7	6	2	4	8

TABLE 12

Spearman Rank Correlation Coefficients

RATIOS	1-2	1-3	1-4	1-5	1-6	1-7	1-8	1-9
SUM OF SQRD DIFF	16	114	212	208	220	324	260	180
CORR COEFFICIENT	0.944	0.601	0.259	0.273	0.231	-0.133	0.091	0.371
RATIOS	1-10	1-11	1-12	1-13	1-14	2-3	2-4	2-5
SUM OF SQRD DIFF	192	170	162	300	162	152	264	252
CORR COEFFICIENT	0.329	0.406	0.434	-0.049	0.434	0.469	0.077	0.119
RATIOS	2-6	2-7	2-8	2-9	2-10	2-11	2-12	2-13
SUM OF SQRD DIFF	248	262	316	136	152	190	156	266
CORR COEFFICIENT	0.133	0.084	-0.105	0.524	0.469	0.336	0.455	0.070
RATIOS	2-14	3-4	3-5	3-6	3-7	3-8	3-9	3-10
SUM OF SQRD DIFF	160	98	140	206	380	116	274	268
CORR COEFFICIENT	0.441	0.657	0.510	0.280	-0.329	0.594	0.042	0.063
RATIOS	3-11	3-12	3-13	3-14	4-5	4-6	4-7	4-8
SUM OF SQRD DIFF	184	118	252	158	20	234	470	150
CORR COEFFICIENT	0.357	0.587	0.119	0.448	0.930	0.182	-0.643	0.476
RATIOS	4-9	4-10	4-11	4-12	4-13	4-14	5-6	5-7
SUM OF SQRD DIFF	382	378	236	226	316	370	214	430
CORR COEFFICIENT	-0.336	-0.332	0.175	0.210	-0.105	-0.294	0.252	-0.503

TABLE 12 (CONT'D)

Spearman Rank Correlation Coefficients

RATIOS	5-8	5-9	5-10	5-11	5-12	5-13	5-14	6-7
SUM OF SQRD DIFF	172	350	342	214	242	352	422	298
CORR COEFFICIENT	0.399	-0.224	-0.196	0.252	0.154	-0.231	-0.476	-0.042
RATIOS	6-8	6-9	6-10	6-11	6-12	6-13	6-14	7-8
SUM OF SQRD DIFF	114	220	188	26	154	516	286	316
CORR COEFFICIENT	0.601	0.231	0.343	0.909	0.462	-0.804	0.000	-0.105
RATIOS	7-9	7-10	7-11	7-12	7-13	7-14	8-9	8-10
SUM OF SQRD DIFF	80	90	266	180	204	220	302	288
CORR COEFFICIENT	0.720	0.685	0.070	0.371	0.287	0.231	-0.056	-0.007
RATIOS	8-11	8-12	8-13	8-14	9-10	9-11	9-12	9-13
SUM OF SQRD DIFF	124	128	346	226	12	188	136	272
CORR COEFFICIENT	0.566	0.552	-0.210	0.210	0.958	0.343	0.524	0.049
RATIOS	9-14	10-11	10-12	10-13	10-14	11-12	11-13	11-14
SUM OF SQRD DIFF	184	184	150	300	210	94	474	234
CORR COEFFICIENT	0.357	0.357	0.476	-0.049	0.266	0.671	-0.657	0.182
RATIOS	12-13	12-14	13-14					
SUM OF SQRD DIFF	272	148	182					
CORR COEFFICIENT	0.049	0.483	0.364					

While four coefficients were very high, 75% of the 91 sets had an absolute value less than .5. Fifteen of the remaining reflected a positive correlation between .5 and .72, while four of the coefficients exhibited a negative correlation which exceeded Ø.5. Only one of these four exceeded an absolute value of .7; a -.8Ø4 between ratios six and thirteen. Once again, these two sets represented comparisons of ratios of different categories. Of note, only two other categories, Liquidity Position and Profitability demonstrated any within category correlation, and then only with a .657 and a .671, respectively.

Time-Series Trends. As presented in Chapter 2, three time-series techniques were used to detect significant systematic patterns in the data. First, a visual examination, as presented in the lower graph of each page in Appendix B, illustrated little significant trend in all the ratios except Ratio 5 (WC/Sales) which appeared to present a somewhat upward trend.

Following the visual examination, two methods of statistical evaluation were performed, autocorrelation function analysis and regression analysis. Table 13 provides these statistical results. Testing of the autocorrelation function found no coefficient values exceeded the amount that would reflect significance, i.e., the two standard error calculation (.666). Only one ratio

TABLE 13

Time Series Analysis - Statistical Results

Ratios	Autocorrelation Coefficients	Regression Analysis "T" Values
C+ST INV/CUR LIAB	Ø.252	-2.125
C+ST INV/T ASSETS	Ø.399	-2.Ø81
QUICK RATIO	-Ø.189	-1.656
CURRENT RATIO	Ø.Ø5Ø	-1.4Ø1
WC/SALES	Ø.Ø95	2.54Ø
C FLOW/SALES	Ø.131	1.645
LT LIAB/SH EQUITY	Ø.522	-1.Ø84
T LIAB/SH EQUITY	Ø.476	-Ø.883
INC/INT EXP	Ø.337	Ø.464
C FLOW/INT EXP	Ø.26Ø	Ø.851
INC/SLAES	Ø.3ØØ	-1.23Ø
INC/T ASSETS	Ø.343	-1.743
SALES/T ASSETS	Ø.345	-1.461
COGS/INVENT	Ø.259	-Ø.21Ø

* Overall 12 companies for 1Ø years.

even appraoched this amount, Ratio 7. A repeated visual examination of Ratio 7 (LT Liab/SH Equity) identified a strong downward trend followed by an upward trend, but no specific trend overall.

Finally, a regression analysis was performed on the yearly medians. The "T" calculated values were compared to the "T" table value of 2.306 (95% significance, two-tailed test). Corresponding with the visual examination, Ratio 5 was the only ratio determined significant at above the 95% level.

Zavgren's Model. As illustrated in Table 14, testing of the Zavgren Model, on the 12 companies used in this research, resulted in unreasonably high probability of failure indices. An in-depth review of the model formulation, to determine potential errors in this research, revealed the model was applied correctly. Additional literature from Zavgren disclosed an application of the model (24:40-42). This application (the testing of a securities company's ratios values for the five years prior to bankruptcy) reflected values which at their best, worst, and average were all inconsistent with the ratio values derived by this thesis (24:41). Furthermore, the ranking of the unreasonably high indices was compared by visual inspection of each company's strength per individual ratio (Appendix B and Table 11), and the Zavgren model ranking did not correspond. These conflicting results demonstrate a

TABLE 14

Zavgren Model Calculations - 1987

COMPANY	INVENTORY TURNOVER	RECEIVE. TURNOVER	CASH POS.	SH-TERM LIQUIDITY	CAPITAL TURNOVER	RETURN ON INVEST.	FINANCIAL LEVERAGE	PROB. INDEX
ALLIED	0.203	0.664	0.034	0.101	1.643	0.076	0.298	0.878
BOEING	0.215	0.540	0.273	0.486	2.791	0.087	0.047	0.875
GEN DYN	0.040	5.849	0.035	0.085	3.194	0.149	0.146	1.000
GRUMMAN	0.202	0.858	0.061	0.209	2.082	0.017	0.403	0.935
McD DOUG	0.270	0.410	0.006	0.011	3.516	0.084	0.206	0.719
NORTHROP	0.093	1.351	0.002	0.002	5.655	0.088	0.003	0.780
RAVEN IND	0.183	0.620	0.030	0.116	2.560	0.106	0.209	0.787
ROCKWELL	0.113	1.342	0.126	0.276	2.554	0.134	0.161	0.941
SUNSTRAND	0.319	0.505	0.009	0.038	1.214	0.031	0.248	0.818
TELEDYNE	0.071	1.743	0.078	0.547	1.197	0.140	0.204	0.915
UNITED	0.221	0.651	0.036	0.091	2.368	0.082	0.256	0.850
WHITTAKER	0.147	1.822	0.021	0.055	1.589	0.047	0.153	0.960

potential need for a model formulation based specifically on defense contractors. An industry specific model could better account for the unique conditions affecting these companies.

Summary

This chapter contained the results of the financial ratio calculations and statistical analyses. The derived medians (benchmarks) and inner quartile range points were presented in Table 5. Some of the ratios fell barely short of meeting all the general "rules of thumb" as regards to standard deviation(s) from the mean, yet all high and low quartile points did fall within one standard deviation from their respective medians. Additional dispersion analysis techniques provided no consensus as far as identifying potential distribution problems. Regarding correlation between the ratios, Table 12 illustrated how 75% of the 91 ratio pairs had correlation of less than Ø.5. The consensus of the time-series trend analysis found only one ratio, WC/Sales, reflected a significant trend suggesting a need for benchmark adjustment. Finally, Table 14 presented the results of the Zavgren Model as calculated on the sample contractors.

The conclusions and recommendations relative to these research findings are presented in the following chapter.

IV. Conclusion

Introduction

The previous chapters provided an introduction to the research, a background review of the literature, a detailed description of the proposed methodology, and the results of the data computation and analyses. The specific objective of this research was to provide ratio "benchmarks" representative to a specific industry definition. Based on this objective, this thesis presented the following research questions:

(1) How should the aerospace defense industry be specifically defined?

(2) Which financial ratio benchmarks should be provided? What information does a specific ratio provide?

(3) How are specific ratio benchmarks calculated and tested for statistical significance?

(4) What problems result from financial ratio analysis?

This chapter will address these four questions and discuss the results of this research as it pertains to each. A final section of this chapter will provide recommendations for future research.

Discussion of Results

Research Question 1. A background review of the literature as presented in Chapter 1 disclosed the capability of defining aircraft and aircraft parts manufacturers by using SIC code 372 of the Standard Industry Classification System. To represent only defense contractors, this research

restricted its sample to include only companies which have contracted with ASD since 1980. Using the Compustat data bank and wanting only those with complete data from 1978-1987, these restrictions allowed for a population sample of 12 defense contractors. These 12 representatives were displayed on pages 28 and 29.

Research Question 2. A literature review revealed an extensive list of ratios expressing numerous "significant" relationships. The literature disclosed that the choice of ratios included in prior studies was largely judgmental and usually based on their popularity in the literature. Due to the need to confine the data to a reasonable/workable size, this research addressed 14 ratios published in a 1988 book by George Foster, Financial Statement Analysis. Although he claims these ratios to be illustrative and not exhaustive, as a published expert in the field of ratio analysis, this researcher felt justified in selecting ratios from within his seven main categories. These categories are: (1) Cash Position, (2) Liquidity, (3) Working Capital/Cash Flow, (4) Capital Structure, (5) Debt Service Coverage, (6) Profitability, and (7) Turnover. Description of these categories was displayed on page 7 with actual ratio formulas on page 8.

Research Question 3. The focus of this study, the calculation of the ratio benchmarks was determined in Chapter 3. The methodology in the previous chapter has

defined the basic benchmark measurement as the median of the sample observations. Additionally, Chapter 2 discussed the need to reflect a reasonable range. The central quartile was selected as this appropriate measurement. With these measurements selected, the primary results of this thesis were presented in Table 5 on page 31. One of the ratios, WC/Sales, displayed a trend which signified a potential need for adjustment to the values in Table 5. Examination of the raw sample data revealed that while sales increased through the years, WC grew by a larger percentage. Given that a user assumes this trend to continue, the benchmark and "reasonable range" points should be icreased by the difference between the sample median and a forecasted value based on a linear regressions line of best fit. The remaining 13 ratios reflected no significant time series trends. With no consensus on any abnormally high distribution dispersion, the researcher believes these 13 ratio norms reflect basic guidelines for comparison within the DOD aerospace industry (assuming the sample is representative of the industry).

A comparison with RMA's six comparable ratio medians, and high and low quartile points (Table 6, page 32) demonstrated that while the values were in the same "ball park," for the most part the broader industry definition by RMA resulted in a broader inner quartile. This finding suggests that a more specific industry definition can produce a more representative norm.

Research Question 4. As stated in Chapter 1, the problems associated with ratio analysis depend on the validity and consistencies of the data being computed. While the most predominate constraint involves the use of alternative methods of inventory valuation, prior studies of random sample companies found that these inconsistent valuation methods resulted in minimal differences in company ranking. Based on these studies and the lack of evidence on available adjustment techniques, this researcher chose the option available of not making any adjustment.

Still, it must be emphasized while ratio analysis is helpful in appraising the present performance of a company and in forecasting its future, it is not a substitute for sound judgment nor does it provide a specific guide to action. While the literature supports that a user is clearly "better off with a ball-park estimate than with no estimate at all," the usefulness of the ratio analysis is dependent on the ability of the user to interpret its meaning as it relates to other ratio values and as well any peculiar conditions affecting the particular company or industry as a whole (4:96).

Recommendations for Future Research

As previously noted, the ratios used in this study, while popular in recent literature, are illustrative and not exhaustive. Thus, beyond the beneficial value derived from the guidelines calculated, perhaps the more significant contribution of

this research is its support for further research. This section will recommend a few of the many areas for future study.

First, a SAS program which took extensive time and expertise to develop is now available (Appendix A). Small adjustments could result in Compustat data access to allow calculation of other ratios. Additionally, these ratios and/or others could be calculated for other specific defense industries, i.e., missile or artillery manufacturers.

Additionally, the researcher believes further study should be devoted to formulating models corresponding in nature to the Zavgren Model and Altman's Z-score Model. This research's testing of ratio correlation (relationships) has already laid some groundwork toward developing a model specific to the aerospace defense industry. Based on these relationships, relationships already determined by Zavgren's and Altman's research, etc.; variables could be tested, with coefficients and intercept calculated from industry-specific data.

The final recommendation for further research concerns the need to update the Defense Logistics Agency's Financial Analysis Training Guide for Preaward and Postaward Financial Analysis, dated September 1978. Additionally, a comparable guide could/should be published to give program managers and their cost analysts guidance with respect to the postaward aspects of financial analysis. Along this line, the FINCAP Analysis pamphlet and its related computer program/data

bank, FINANDAS, could be reevaluated concerning the potential for their future use. Although canceled in the early 1980s due to exhorbitant computer storage cost, a future study of the use of FINANDAS could demonstrate that its benefits now outweigh the current lower computer costs.

Appendix A: Statistical Analysis System (SAS) Program for Accessing/Manipulating COMPUSTAT Data Bank

```
1.  ** LOAD UP OF COMPUSTAT DATA BANK **
2   FILENAME IPO 'HSCOOO$DUA6:[COMPUSTAT]IND_ASCII.DAT';
3   OPTIONS LS=80 NODATE NONUMBER;
4   DATA TAPE;
5   INFILE IPO RECFM=FIXED BLKSIZE=9934 LRECL=9934;
6   INPUT
7   @1 DNUM 4.0 @5 CNUM $CHAR6. @11 CIC 3.0 @14 REC 1.0
    @15 FILE 2.0 @17
8   ZLIST 2.0 @19 CONAME $CHAR28. @47 SMBL $CHAR8. @75
    XREL 4.0
9   @79 STK 1.0  @80 DUP 2.0 @@;
10  ** LOOP TO REQUEST SPECIFIC SIC CODES **
11  IF DNUM EQ 3721 OR DNUM EQ 3724 OR DNUM EQ 3728 THEN
    DO;
12     PTR1=55;
13     PTR2=65;
14     PTR3=38;
15     PTR4=93;
16     PTR5=443;
17  ** LOOP LOADS ALL VARIABLES FOR REQUESTED SIC CODES **
18        DO I = 1 TO 5;
19        INPUT
20           @PTR1 FYR 2.0
21           @PTR2 YEAR 2.0
22           @PTR3 VCODE 1.0
23           @PTR4 (AFTNT1-AFTNT35) ($CHAR2.0)
24           @PTR5  (V1-V5) (8.3)
25                  (V6-V8) (10.3)
26                  (V9-V11) (8.3)
27                  (V12)   (10.3)
28                  (V13-V24) (8.3)
29                  (V25) (10.3)
30                  (V26) (8.3)
31                  (V27) (10.6)
32                  (V28) (10.3)
33                  (V29-V36) (8.3)
34                  (V37) (10.3)
35                  (V38-V39) (8.3)
36                  (V40-V41) (10.3)
37                  (V42-V86) (8.3)
38                  (V87) (10.3)
39                  (V88-V99) (8.3)
40                  (V100) (10.3)
41                  (V101-V116) (8.3)
42                  (V117) (10.3)
43                  (V118-V119) (8.3)
44                  (V120) (10.3)
45                  (V121-V130) (8.3)
46                  (V131) (10.3)
47                  (V132-V140) (8.3)
```

```
48                    (V141) (10.3)
49                    (V142-V146) (8.3)
50                    (V147) (10.3)
51                    (V148-V162) (8.3)
52                    (V163) (10.3)
53                    (V164-V174) (8.3)
54                    (V175) (10.3) @@;
55    ** VARIABLE NAMES USED DISPLAYED AT END **
56              PTR1 + 2;
57                 PTR2 + 2;
58                 PTR3 + 1;
59                 PTR4 + 70;
60                 PTR5 + 1438;
61              OUTPUT;
62
63              END;
64              END;
65    ELSE DO; INPUT; DELETE; END;
66    INPUT;
67    ** DELETION OF UNWANTED COMPANIES BY COMPANY SYMBOL **
68    DATA NEW; SET TAPE;
69    IF SMBL EQ 'PAR' OR SMBL EQ 'HEI' OR SMBL EQ 'UNC'
70    OR SMBL EQ 'DCO' OR SMBL EQ 'MOG.A' OR SMBL EQ 'OEA'
71    OR SMBL EQ 'PH' OR SMBL EQ 'RHR'
72    OR SMBL EQ 'SER' OR SMBL EQ 'PSX'
73    OR YEAR LE 77 OR YEAR EQ 88 THEN DELETE;
74    ** RATIO CALCULATIONS **
75    RATIO1=V1/V5;
76    RATIO2=V1/V6;
77    RATIO3=(V1+V2)/V5;
78    RATIO4=V4/V5;
79    RATIO5=V121/V12;
80    RATIO6=(V18+V125)/V12;
81    RATIO7=V9/(V6-(V5+V9));
82    RATIO8=(V5+V9)/(V6-(V5+V9));
83    RATIO9=V18/V15;
84    RATIO10=(V18+V125)/V15;
85    RATIO11=V18/V12;
86    RATIO12=V18/V6;
87    RATIO13=V12/V6;
88    RATIO14=V41/V3;
89    ** PRINT VARIABLES BY COMPANY **
90    PROC SORT DATA=NEW; BY SMBL;
91    PROC PRINT DATA=NEW NOOBS; BY SMBL;
92    VAR YEAR V1 V2 V3 V4 V5 V6 V9 V12 V15 V18 V41 V121 V125;
93    ** CALCULATE RATIO STATISTICS PER EACH OF 14 RATIOS **
94    PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO1;
95    OUTPUT OUT=RAT1 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
96
97    PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO2;
```

```
 98   OUTPUT OUT=RAT2 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
 99
100   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO3;
101   OUTPUT OUT=RAT3 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
102
103   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO4;
104   OUTPUT OUT=RAT4 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
105
106   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO5;
107   OUTPUT OUT=RAT5 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
108
109   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO6;
110   OUTPUT OUT=RAT6 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
111
112   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO7;
113   OUTPUT OUT=RAT7 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
114
115   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO8;
116   OUTPUT OUT=RAT8 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
117
118   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO9;
119   OUTPUT OUT=RAT9 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
120
121   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO10;
122   OUTPUT OUT=RAT10 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
123
124   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO11;
125   OUTPUT OUT=RAT11 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
126
127   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO12;
128   OUTPUT OUT=RAT12 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
129
130   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO13;
131   OUTPUT OUT=RAT13 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
132
133   PROC UNIVARIATE NOPRINT DATA=NEW;VAR RATIO14;
134   OUTPUT OUT=RAT14 N=N MEAN=MEAN STD=STD MEDIAN=MEDIAN
      MIN=MIN MAX=MAX;
135   ** ESTABLISH DATA FILE PER RATIO **
```

```
136   DATA ONE;
137   SET RAT1;
138   RATIO='RATIO1';
139
140   DATA TWO;
141   SET RAT2;
142   RATIO='RATIO2';
143
144   DATA THREE;
145   SET RAT3;
146   RATIO='RATIO3';
147
148   DATA FOUR;
149   SET RAT4;
150   RATIO='RATIO4';
151
152   DATA FIVE;
153   SET RAT5;
154   RATIO='RATIO5';
155
156   DATA SIX;
157   SET RAT6;
158   RATIO='RATIO6';
159
160   DATA SEVEN;
161   SET RAT7;
162   RATIO='RATIO7';
163
164   DATA EIGHT;
165   SET RAT8;
166   RATIO='RATIO8';
167
168   DATA NINE;
169   SET RAT9;
170   RATIO='RATIO9';
171
172   DATA TEN;
173   SET RAT10;
174   RATIO='RATIO10';
175
176   DATA ELEVEN;
177   SET RAT11;
178   RATIO='RATIO11';
179
180   DATA TWELVE;
181   SET RAT12;
182   RATIO='RATIO12';
183
184   DATA THIRTEEN;
185   SET RAT13;
186   RATIO='RATIO13';
187
```

```
188   DATA FOURTEEN;
189   SET RAT14;
190   RATIO='RATIO14';
191
192   DATA TOTRAT;
193   SET ONE TWO THREE FOUR FIVE SIX SEVEN EIGHT NINE TEN
194   ELEVEN TWELVE THIRTEEN FOURTEEN;
195   ** PRINT STATISTICS PER RATIO **
196   PROC PRINT; VAR RATIO N MEAN MEDIAN STD MIN MAX;
197   ** PRINT RATIOS BY RATIO # SORTED BY COMPANY **
198   PROC SORT DATA=NEW; BY SMBL;
199   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO1;
200   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO2;
201   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO3;
202   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO4;
203   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO5;
204   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO6;
205   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO7;
206   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO8;
207   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO9;
208   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO10;
209   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO11;
210   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO12;
211   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO13;
212   PROC PRINT DATA=NEW NOOBS; BY SMBL; VAR YEAR RATIO14;
213   RUN;
```

COMPUSTAT VARIABLE DEFINITIONS (20: Section 4 21-23, 27)

V1: Cash and Short-Term Investments
V2: Receivables
V3: Inventories
V4: Current Assets
V5: Current Liabilities
V6: Total Assets
V9: Long-Term Debt
V12: Net Sales
V15: Interest Expense
V18: Income Before Extraordinary Items
V41: Cost of Goods Sold
V121: Working Capital
V125: Depreciation and Amortization

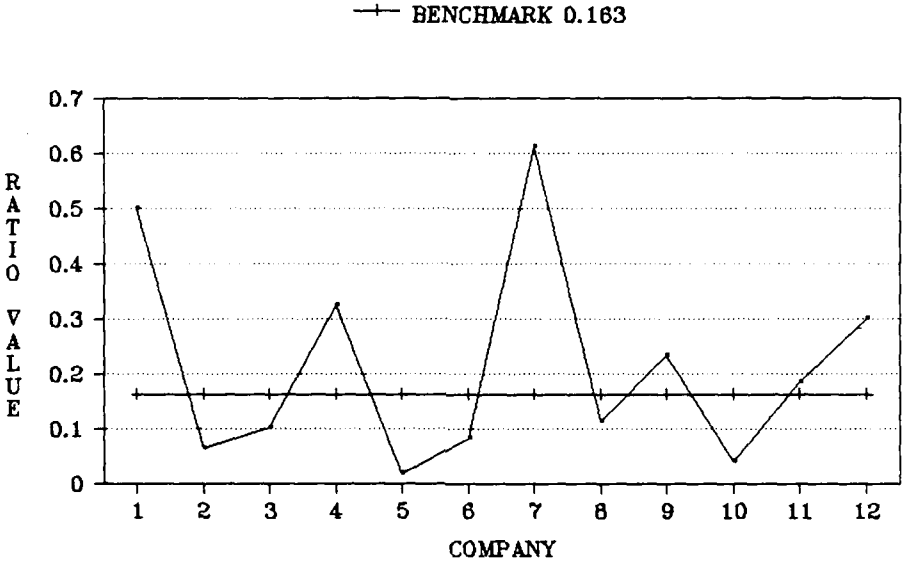
Appendix B: Graphical Display of Median Value Comparison By Company/By Year Per Ratio

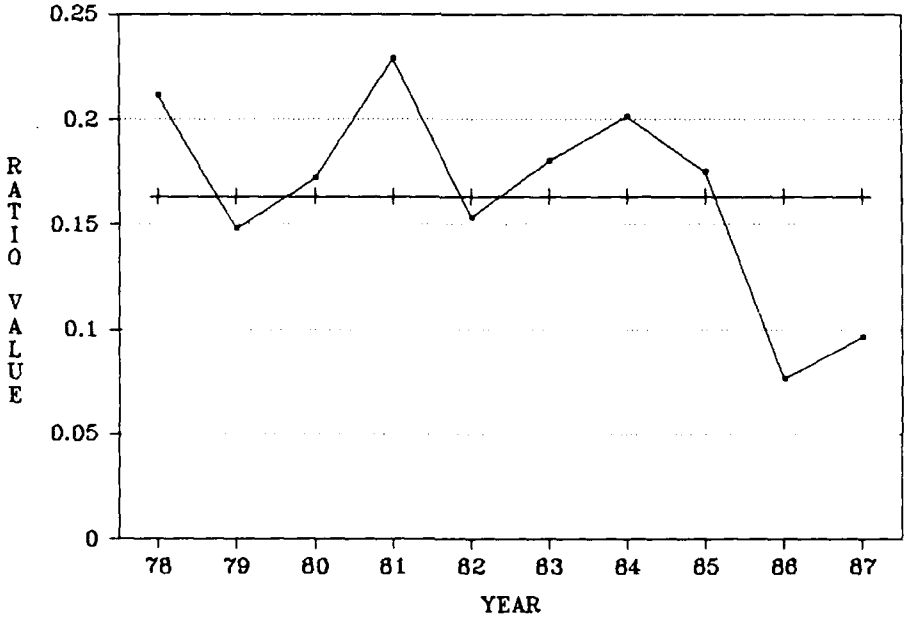
'87 TOTAL ASSETS ($B)

1.	BOEING	12.566
2.	UNITED TECHNOLOGIES	11.928
3.	ALLIED SIGNAL	10.226
4.	ROCKWELL	8.739
5.	McDONNELL DOUGLAS	8.536
6.	GENERAL DYNAMICS	5.032
7.	TELEDYNE	3.135
8.	NORTHROP	3.124
9.	GRUMMAN	2.254
10.	SUNSTRAND	1.48
11.	WHITTAKER	.43
12.	RAVEN	.02

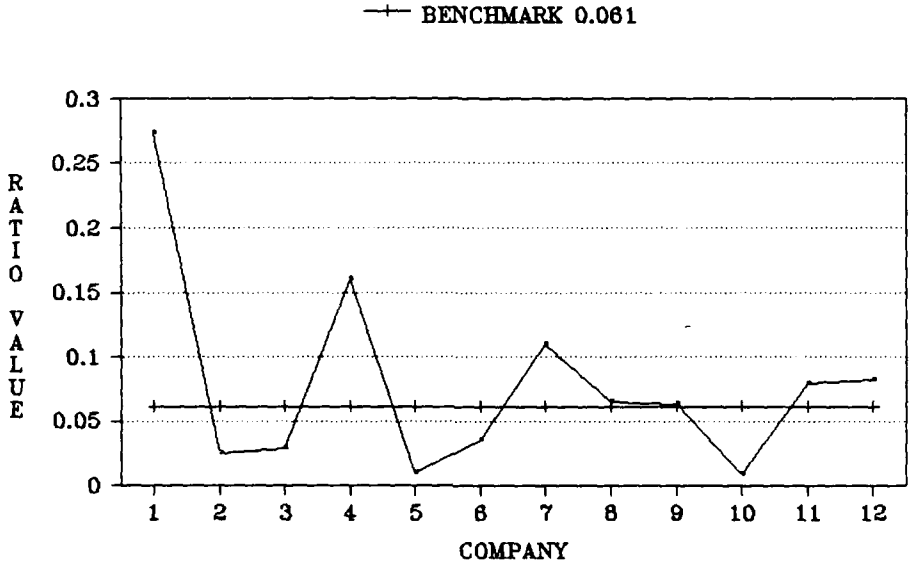
*Companies listed by size (see Table 4)

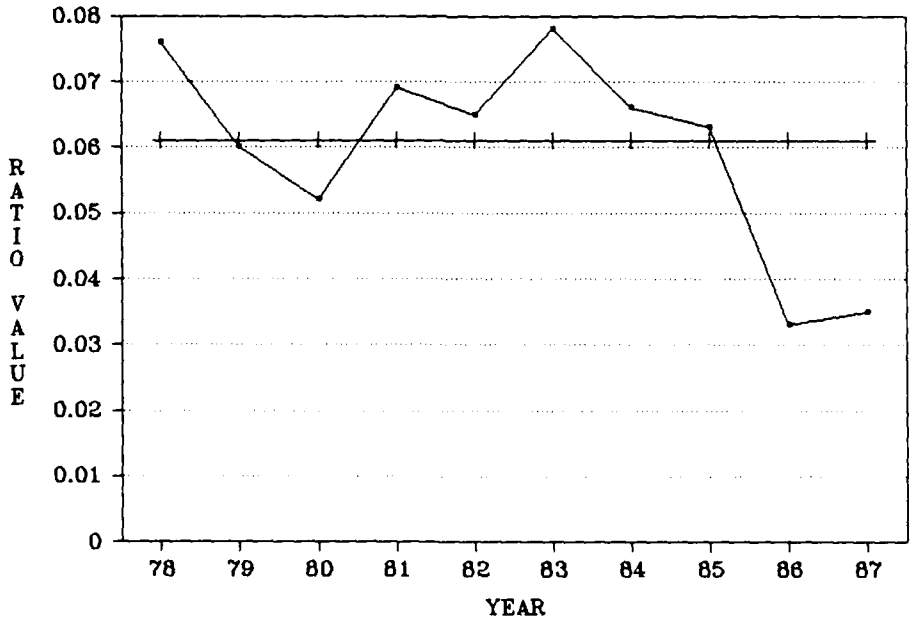
(CASH & SHORT TERM INVESTMENTS)/ (CURRENT LIABILITIES)



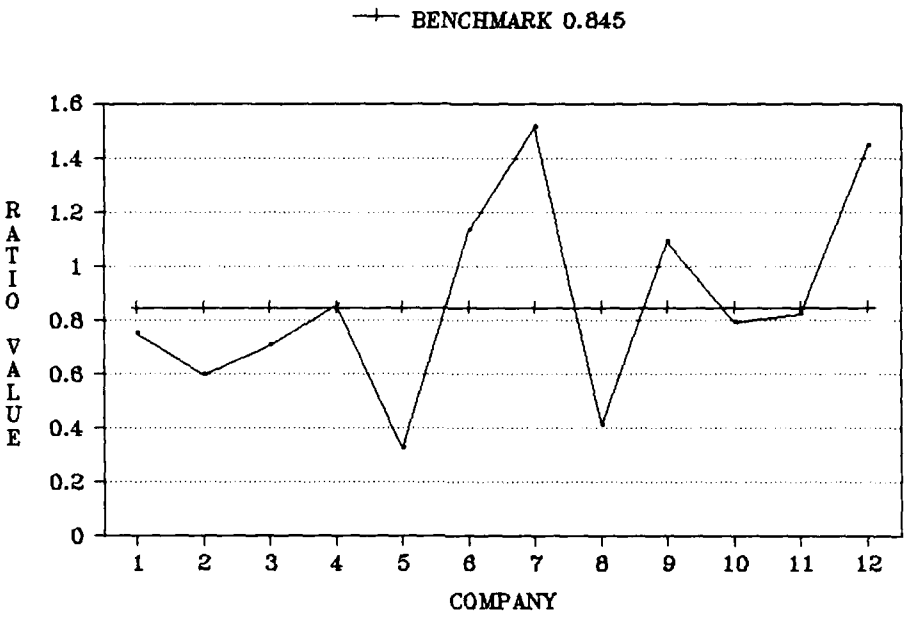


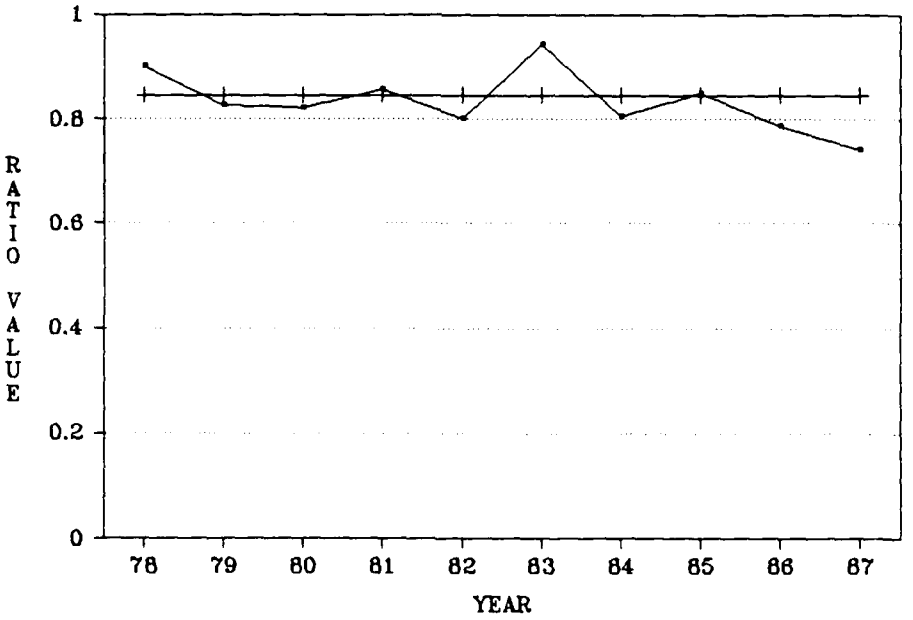
(CASH & SHORT TERM INVESTMENTS)/ (TOTAL ASSETS)



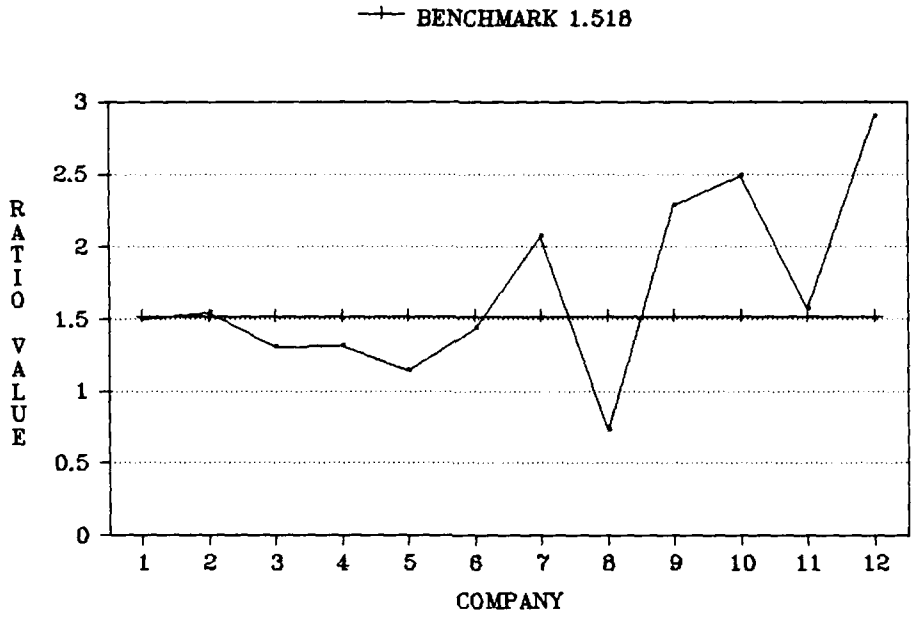


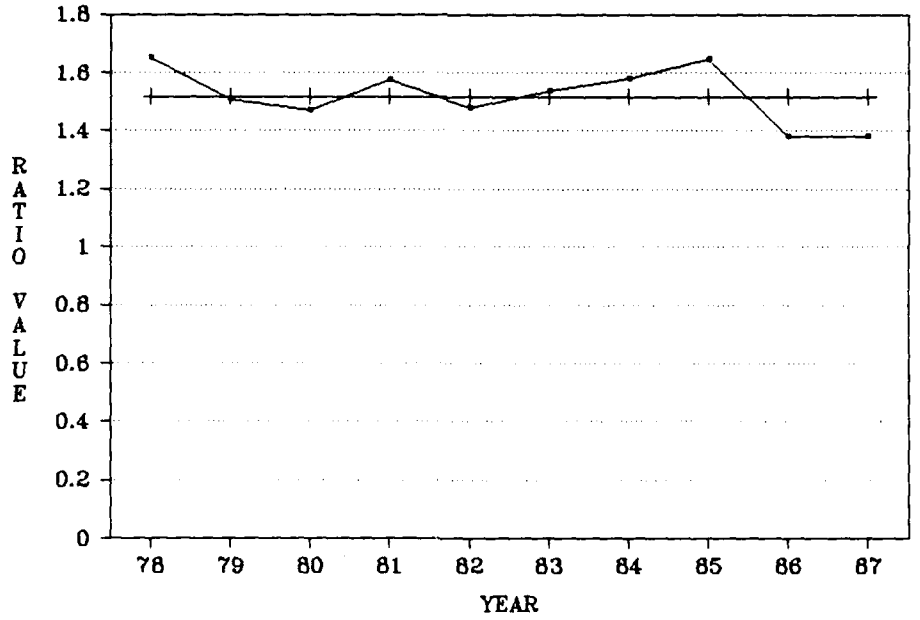
QUICK RATIO


BENCHMARK 0.845
RATIO VALUE
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12
COMPANY

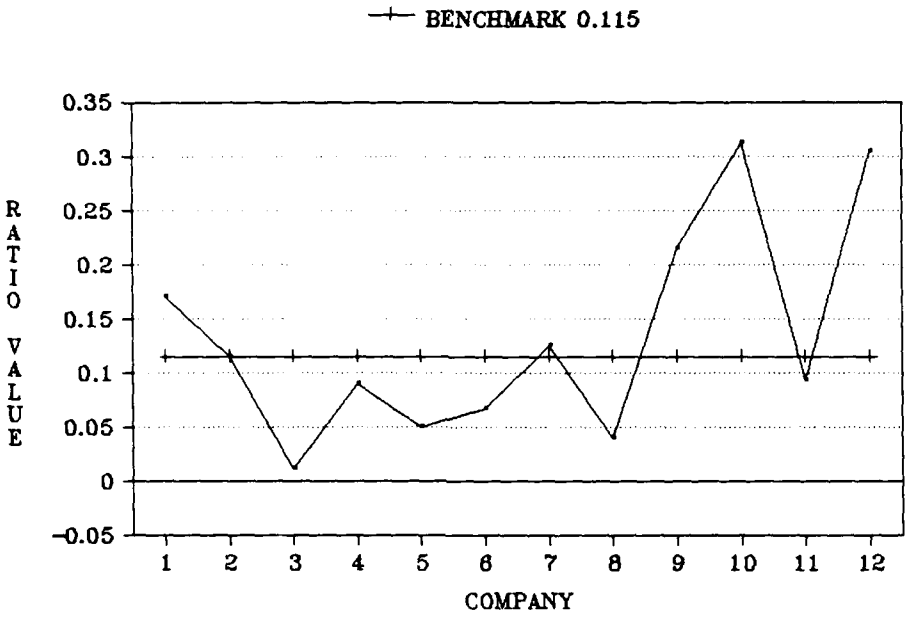

RATIO VALUE
1
0.8
0.6
0.4
0.2
0
78 79 80 81 82 83 84 85 86 87
YEAR

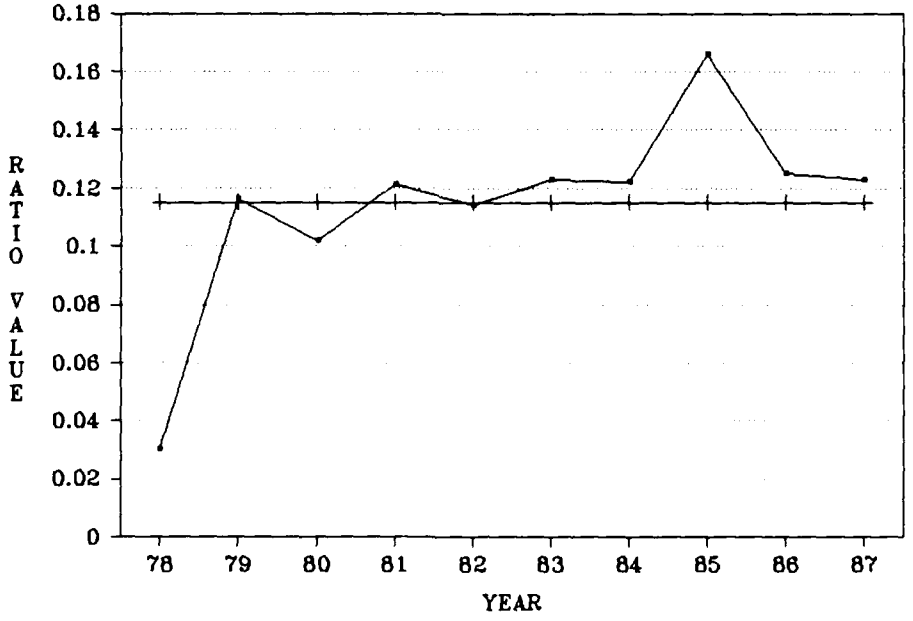
CURRENT RATIO



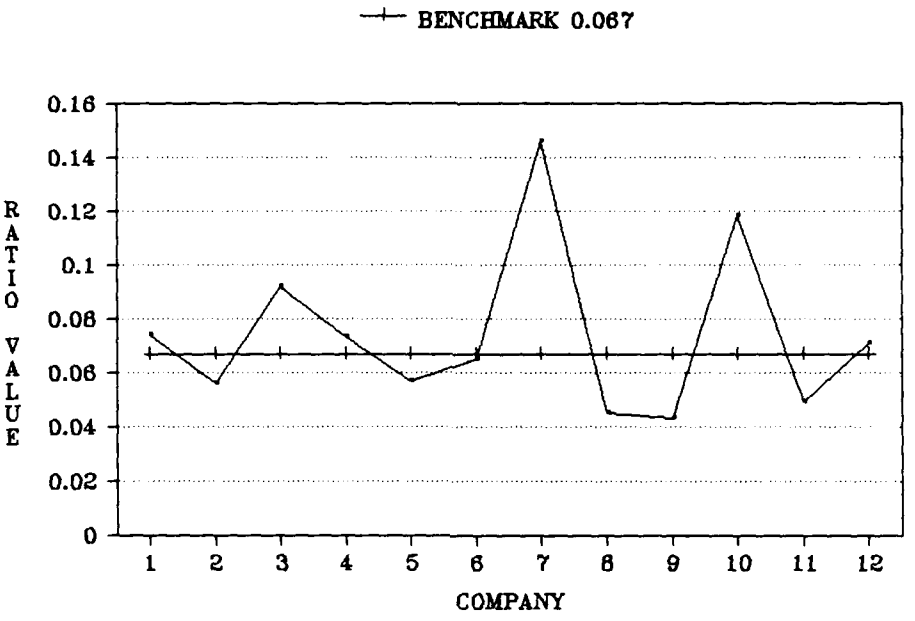


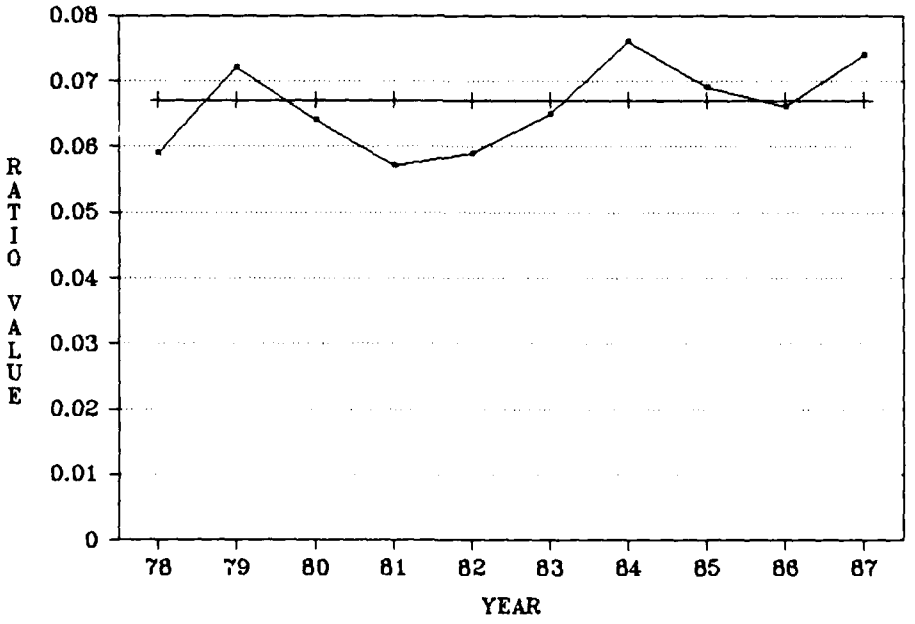
(WORKING CAPITAL)/(SALES)



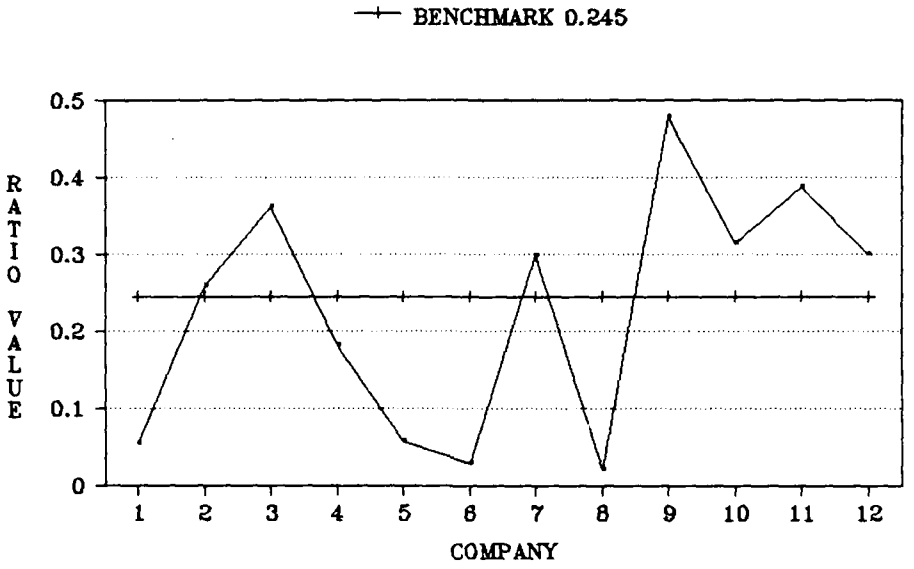


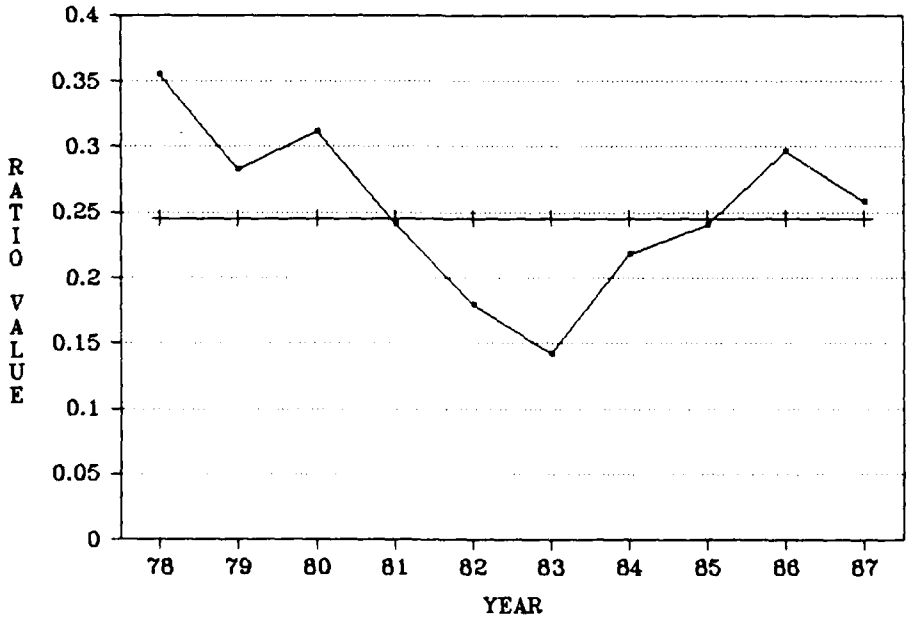
(CASH FLOW)/(SALES)



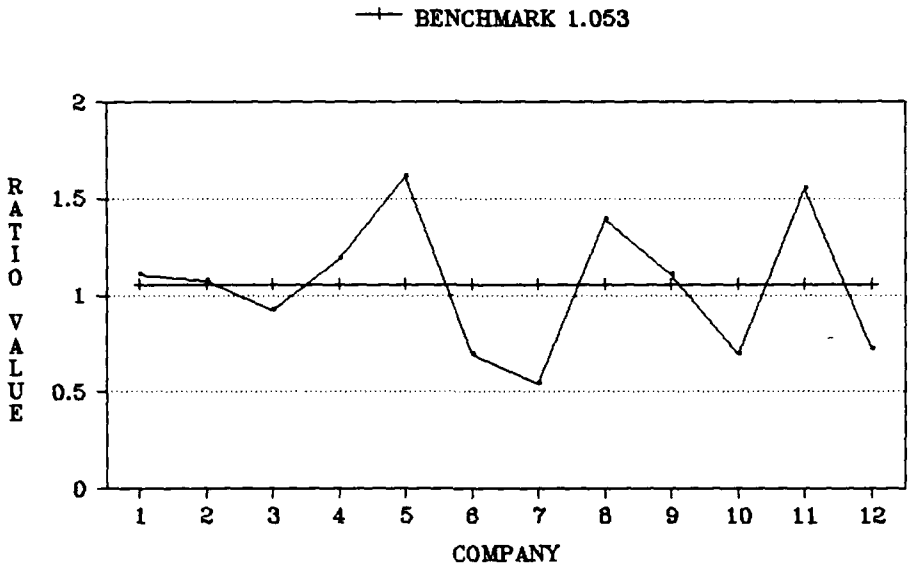


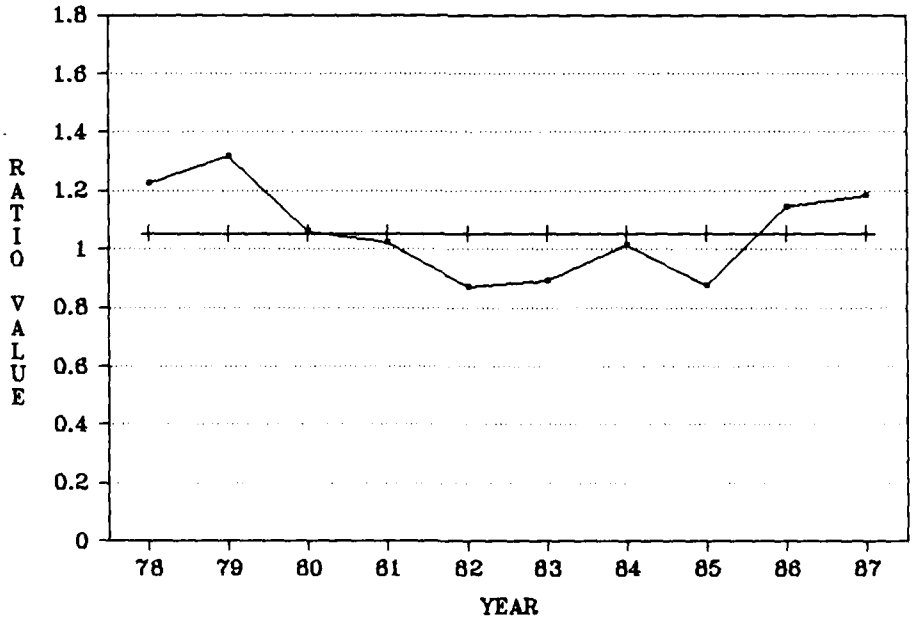
(LONG TERM LIABILITIES)/ (SHAREHOLDER EQUITY)



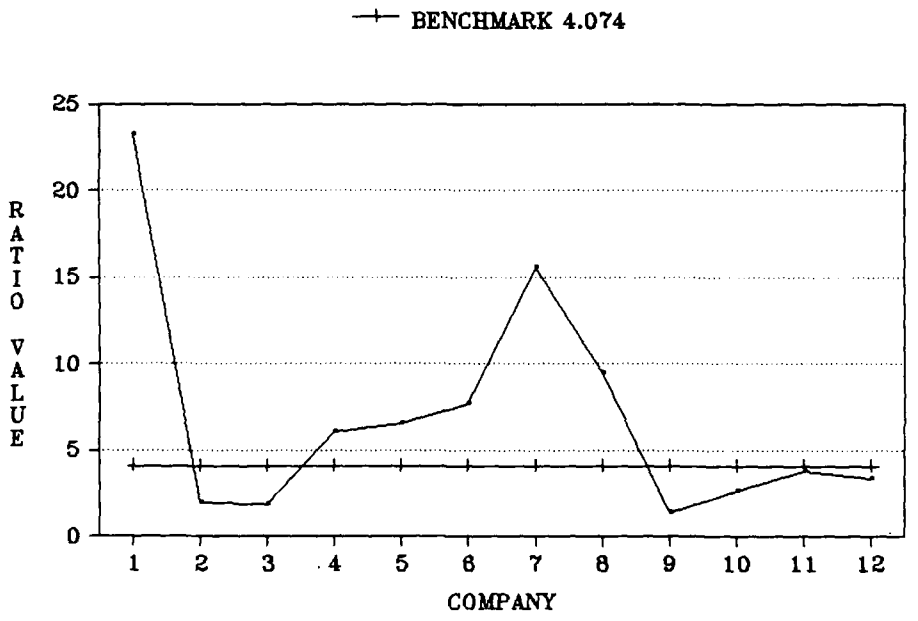


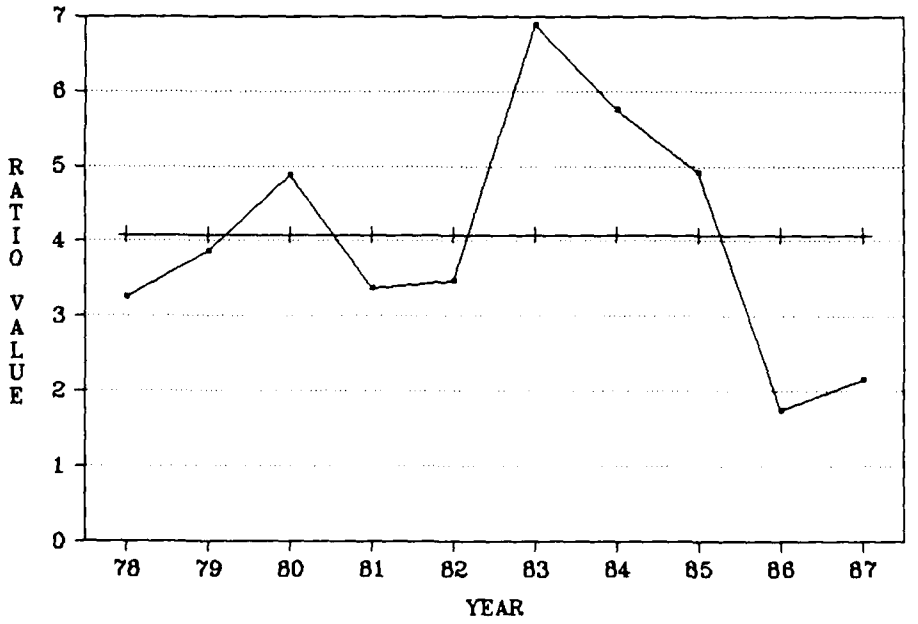
(TOTAL LIABILITIES)/
(SHAREHOLDER EQUITY)



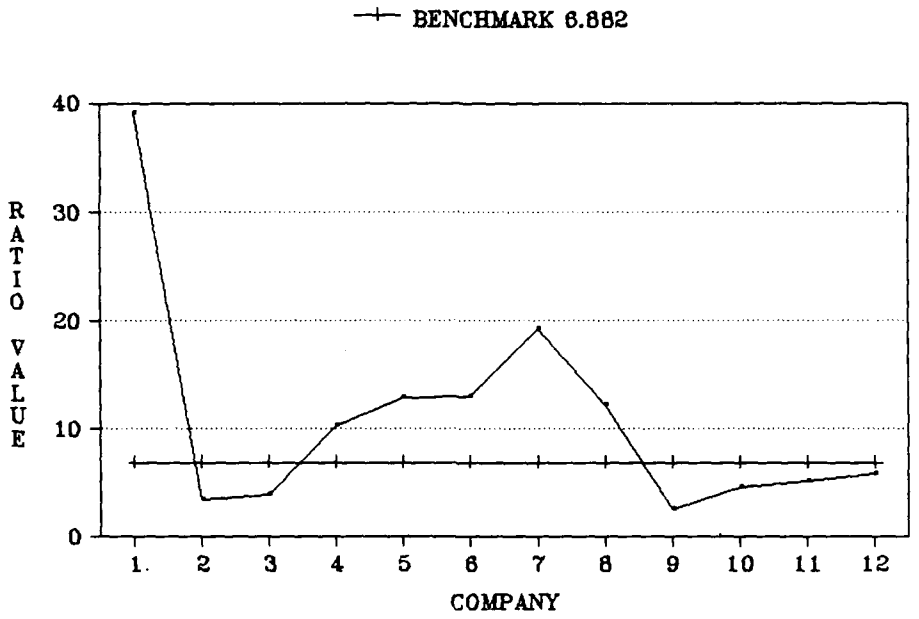


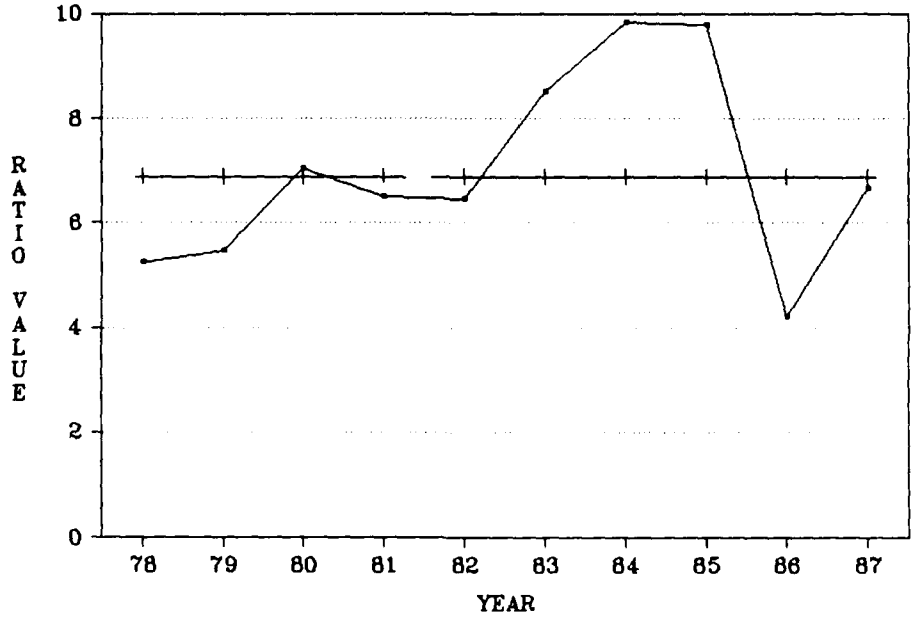
(INCOME)/(INTEREST EXPENSE)



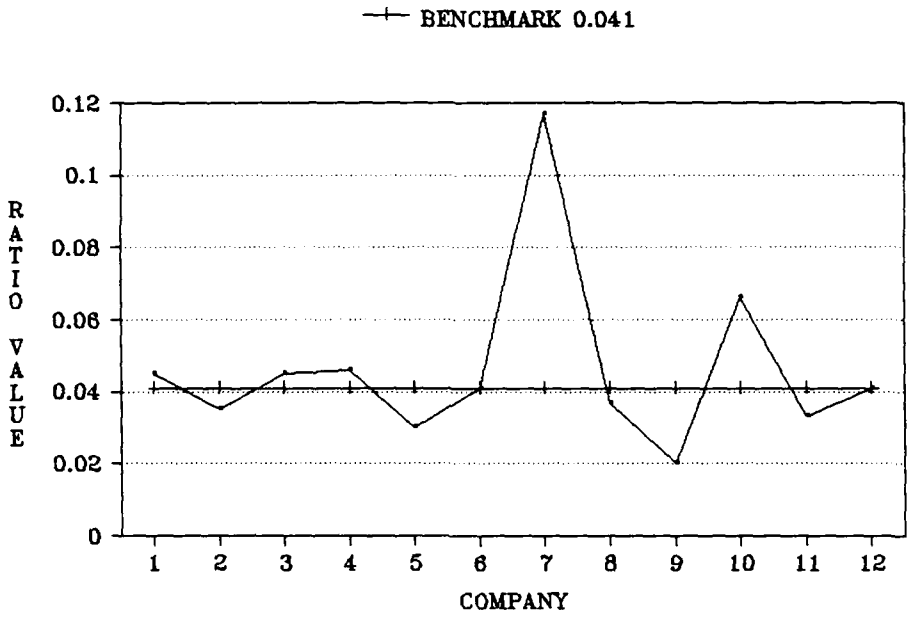


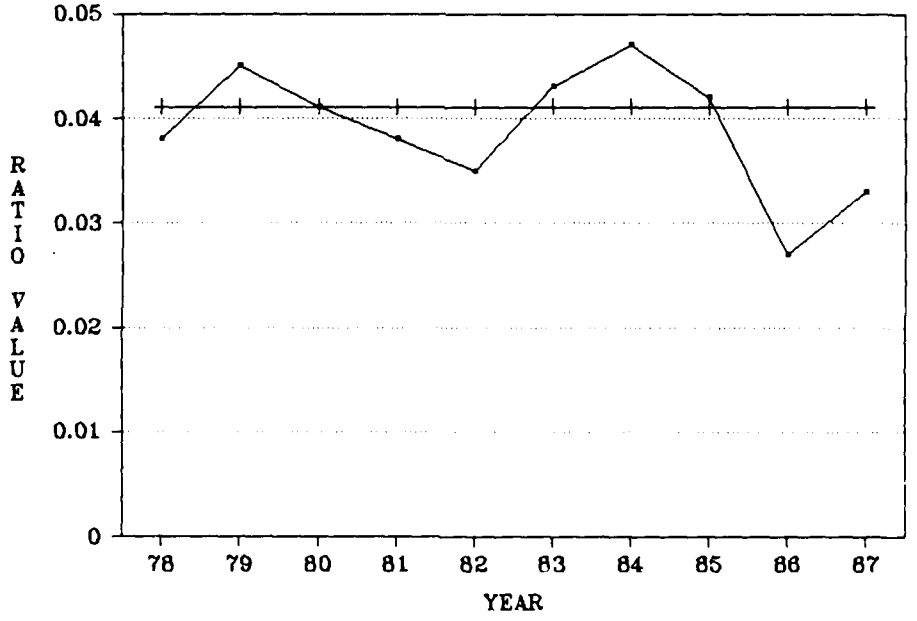
(CASH FLOW)/(INTEREST EXPENSE)



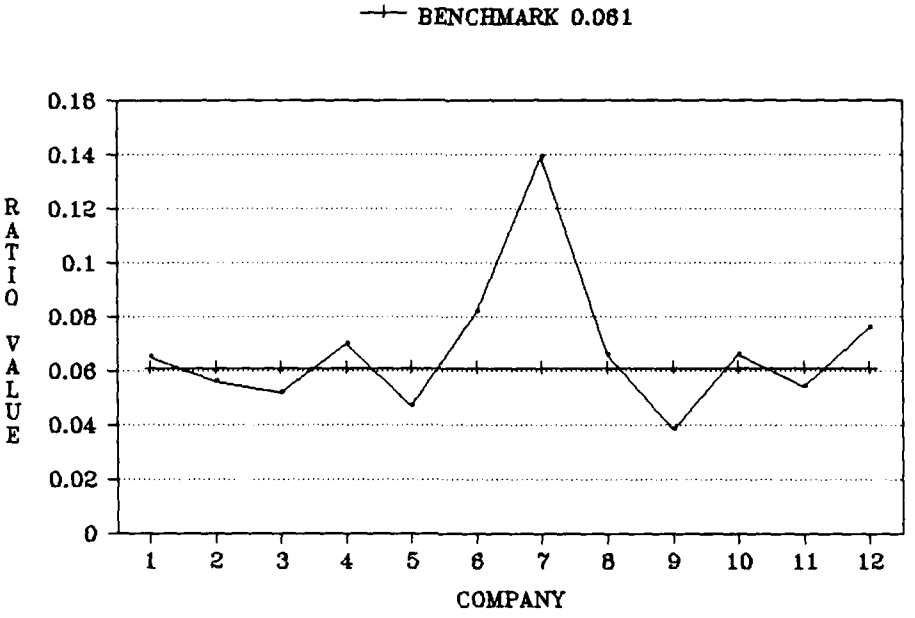


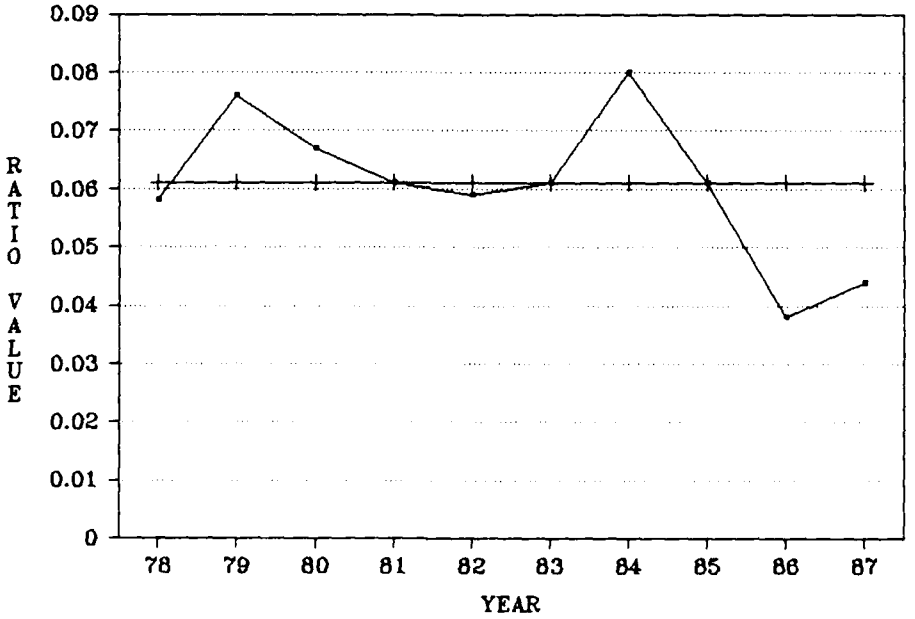
(INCOME)/(SALES)



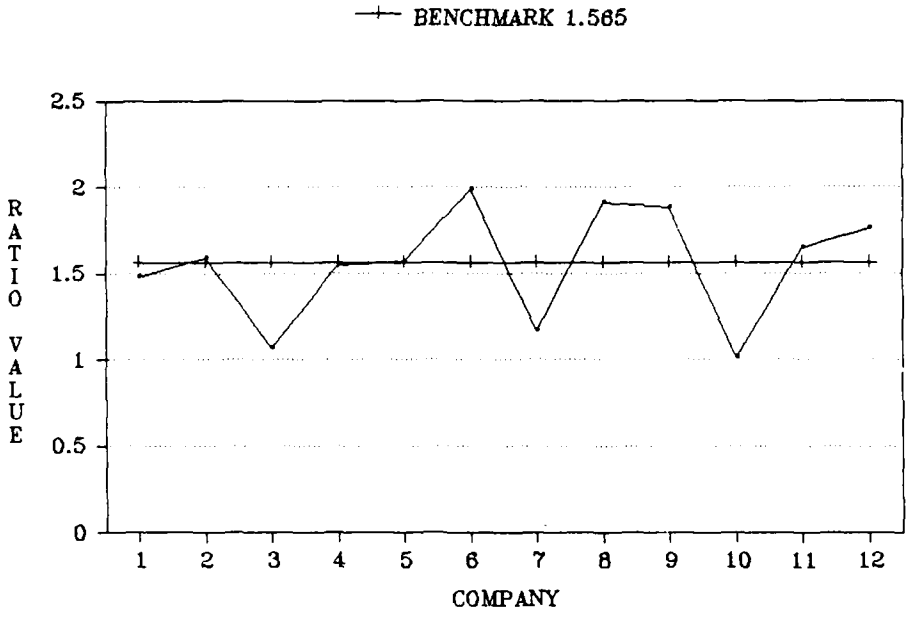


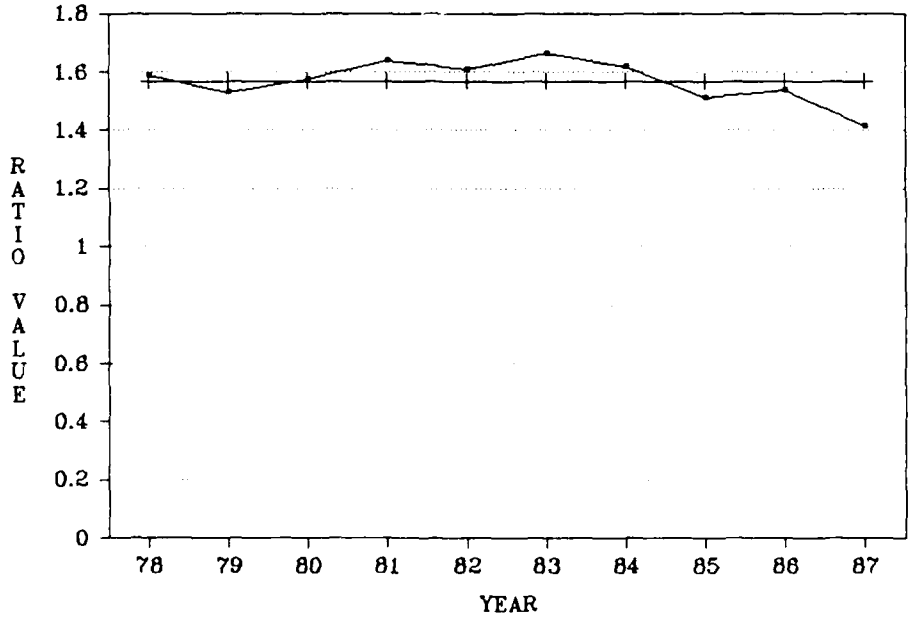
(INCOME)/(TOTAL ASSETS)



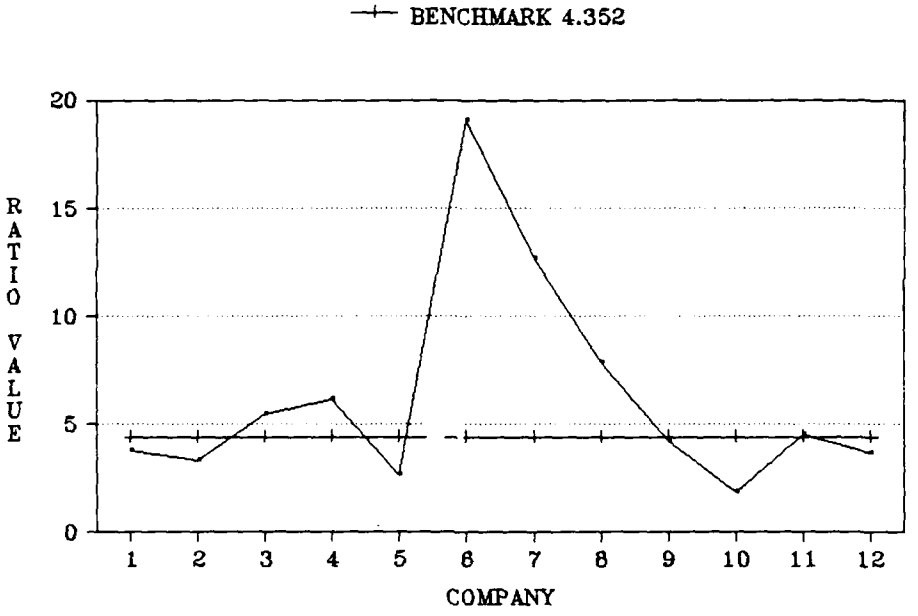


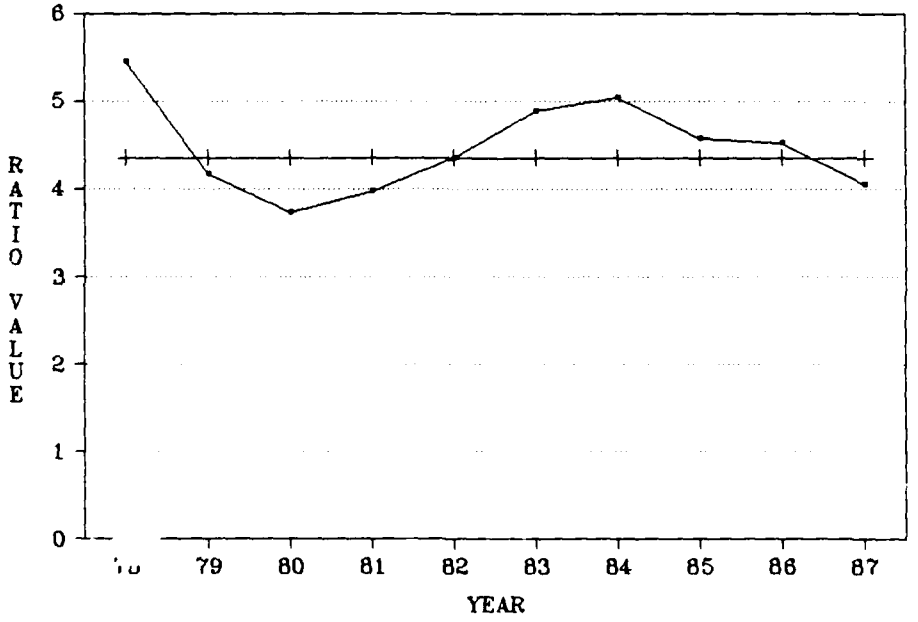
(SALES)/(TOTAL ASSETS)





(COST OF GOODS SOLD)/(INVENTORY)





Appendix C: Calculated Financial Ratios

CASH + SHORT TERM INVESTMENTS / CURRENT LIABILITIES

	COMPANY					
YEAR	1	2	3	4	5	6
1978	0.103	0.996	0.081	0.181	0.323	0.533
1979	0.094	0.836	0.056	0.145	0.171	0.312
1980	0.160	0.516	0.025	0.265	0.005	0.471
1981	0.132	0.283	0.017	0.322	0.006	0.291
1982	0.146	0.082	0.098	0.259	0.105	0.161
1983	0.035	0.342	0.176	0.263	0.153	0.065
1984	0.060	0.395	0.192	0.616	0.009	0.003
1985	0.373	0.727	0.007	0.185	0.020	0.005
1986	0.053	0.737	0.087	0.207	0.018	0.003
1987	0.101	0.486	0.085	0.209	0.011	0.002

	COMPANY					
YEAR	7	8	9	10	11	12
1978	0.007	0.276	0.037	0.734	0.210	0.213
1979	0.036	0.312	0.044	0.628	0.067	0.150
1980	0.097	0.338	0.050	0.593	0.046	0.184
1981	0.603	0.401	0.034	1.158	0.058	0.174
1982	0.063	0.364	0.041	1.840	0.040	0.257
1983	0.797	0.425	0.087	2.052	0.069	0.183
1984	0.484	0.404	0.026	0.548	0.060	0.211
1985	0.737	0.136	0.008	0.165	0.236	0.456
1986	0.035	0.222	0.064	0.280	0.058	0.091
1987	0.116	0.276	0.038	0.547	0.091	0.055

* Companies listed alphabetically

CASH + SHORT TERM INVESTMENTS / TOTAL ASSETS

	COMPANY					
YEAR	1	2	3	4	5	6
1978	0.021	0.517	0.035	0.060	0.190	0.280
1979	0.030	0.470	0.021	0.055	0.097	0.151
1980	0.042	0.272	0.010	0.061	0.003	0.252
1981	0.034	0.132	0.006	0.062	0.004	0.155
1982	0.028	0.039	0.037	0.068	0.062	0.092
1983	0.011	0.147	0.056	0.074	0.085	0.038
1984	0.018	0.188	0.062	0.190	0.006	0.002
1985	0.085	0.347	0.003	0.065	0.011	0.003
1986	0.017	0.377	0.043	0.066	0.010	0.002
1987	0.034	0.273	0.035	0.061	0.006	0.002

	COMPANY					
YEAR	7	8	9	10	11	12
1978	0.002	0.128	0.009	0.169	0.070	0.083
1979	0.013	0.154	0.012	0.126	0.026	0.064
1980	0.019	0.167	0.010	0.093	0.020	0.084
1981	0.134	0.203	0.008	0.156	0.022	0.077
1982	0.228	0.175	0.009	0.223	0.015	0.117
1983	0.218	0.198	0.017	0.210	0.027	0.082
1984	0.136	0.196	0.006	0.071	0.023	0.077
1985	0.160	0.062	0.002	0.024	0.092	0.139
1986	0.008	0.098	0.012	0.043	0.024	0.042
1987	0.030	0.126	0.009	0.078	0.036	0.021

QUICK RATIO

	COMPANY					
YEAR	1	2	3	4	5	6
1978	Ø.874	1.228	Ø.998	Ø.95Ø	Ø.492	Ø.921
1979	Ø.659	1.Ø32	1.Ø71	Ø.929	Ø.377	Ø.678
198Ø	Ø.824	Ø.676	1.116	1.346	Ø.214	Ø.67Ø
1981	Ø.811	Ø.447	1.292	1.541	Ø.196	Ø.581
1982	Ø.748	Ø.235	1.148	1.1ØØ	Ø.3Ø3	Ø.338
1983	Ø.57Ø	Ø.51Ø	1.341	1.Ø42	Ø.38Ø	Ø.285
1984	Ø.547	Ø.587	1.378	1.224	Ø.257	Ø.271
1985	Ø.839	Ø.927	Ø.858	Ø.864	Ø.334	Ø.372
1986	Ø.463	Ø.949	Ø.957	1.132	Ø.358	Ø.366
1987	Ø.532	Ø.822	1.237	1.Ø81	Ø.312	Ø.443

	COMPANY					
YEAR	7	8	9	1Ø	11	12
1978	Ø.963	Ø.878	Ø.767	1.528	Ø.883	Ø.87Ø
1979	Ø.997	Ø.833	Ø.754	1.42Ø	Ø.593	Ø.817
198Ø	1.434	Ø.814	1.Ø9Ø	1.496	Ø.544	Ø.819
1981	1.799	Ø.889	Ø.964	2.152	Ø.575	Ø.824
1982	2.172	Ø.885	Ø.817	2.679	Ø.549	Ø.784
1983	1.8Ø9	Ø.974	Ø.962	2.998	Ø.579	Ø.922
1984	1.459	Ø.94Ø	Ø.668	1.731	Ø.61Ø	1.Ø1Ø
1985	1.93Ø	Ø.656	Ø.6ØØ	1.2ØØ	Ø.765	1.299
1986	Ø.998	Ø.721	Ø.851	1.2Ø4	Ø.595	Ø.553
1987	1.Ø46	Ø.775	Ø.7Ø9	1.459	Ø.616	Ø.654

CURRENT RATIO

COMPANY

YEAR	1	2	3	4	5	6
1978	1.432	1.496	Ø.134	2.Ø7Ø	1.558	1.35Ø
1979	1.2Ø9	1.318	1.42Ø	1.989	1.347	1.428
198Ø	1.395	1.311	1.5Ø1	3.394	1.263	1.275
1981	1.465	1.453	1.6Ø7	4.183	1.142	1.Ø89
1982	1.344	1.5Ø2	1.329	2.838	1.2ØØ	Ø.659
1983	1.2Ø1	1.611	1.583	2.555	1.1Ø4	Ø.621
1984	1.2Ø2	1.527	1.612	2.248	Ø.945	Ø.649
1985	1.643	1.532	1.166	1.875	1.11Ø	Ø.692
1986	1.26Ø	1.498	1.182	2.Ø91	1.147	Ø.679
1987	1.18Ø	1.318	1.44Ø	2.312	1.125	Ø.763

COMPANY

YEAR	7	8	9	1Ø	11	12
1978	2.633	1.47Ø	2.483	2.Ø1Ø	1.824	1.739
1979	2.262	1.387	2.457	1.834	1.6Ø1	1.584
198Ø	3.8Ø3	1.365	3.224	1.938	1.437	1.553
1981	3.523	1.351	2.6Ø1	2.596	1.54Ø	1.627
1982	3.662	1.3Ø4	2.49Ø	3.Ø22	1.51Ø	1.453
1983	3.Ø16	1.326	2.66Ø	3.443	1.488	1.494
1984	2.76Ø	1.272	2.Ø84	2.139	1.551	1.795
1985	3.464	1.Ø53	1.866	1.653	1.673	2.21Ø
1986	2.781	1.125	2.623	1.8ØØ	1.5ØØ	1.221
1987	2.477	1.158	2.Ø78	2.1Ø5	1.584	1.189

WORKING CAPITAL / SALES

	COMPANY					
YEAR	1	2	3	4	5	6
1978	Ø.ØØØ	Ø.169	Ø.Ø6Ø	Ø.148	Ø.159	Ø.ØØØ
1979	Ø.ØØØ	Ø.1Ø8	Ø.Ø64	Ø.2Ø3	Ø.126	Ø.ØØØ
198Ø	Ø.ØØØ	Ø.1Ø3	Ø.Ø71	Ø.29Ø	Ø.1ØØ	Ø.ØØØ
1981	Ø.ØØØ	Ø.15Ø	Ø.Ø8Ø	Ø.343	Ø.Ø51	Ø.ØØØ
1982	Ø.ØØØ	Ø.199	Ø.Ø61	Ø.242	Ø.Ø75	Ø.ØØØ
1983	Ø.Ø23	Ø.176	Ø.Ø79	Ø.213	Ø.Ø34	-Ø.1Ø7
1984	Ø.Ø26	Ø.2Ø6	Ø.Ø76	Ø.218	-Ø.Ø21	-Ø.1Ø6
1985	Ø.213	Ø.172	Ø.Ø4Ø	Ø.16Ø	Ø.Ø39	-Ø.Ø79
1986	Ø.Ø81	Ø.173	Ø.Ø46	Ø.198	Ø.Ø5Ø	-Ø.Ø95
1987	Ø.Ø56	Ø.146	Ø.Ø99	Ø.26Ø	Ø.Ø46	-Ø.Ø8Ø

	COMPANY					
YEAR	7	8	9	1Ø	11	12
1978	Ø.286	Ø.ØØØ	Ø.31Ø	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
1979	Ø.3Ø3	Ø.131	Ø.315	Ø.124	Ø.ØØØ	Ø.ØØØ
198Ø	Ø.31Ø	Ø.123	Ø.372	Ø.127	Ø.ØØØ	Ø.ØØØ
1981	Ø.318	Ø.128	Ø.334	Ø.189	Ø.115	Ø.ØØØ
1982	Ø.35Ø	Ø.Ø96	Ø.315	Ø.276	Ø.114	Ø.114
1983	Ø.312	Ø.Ø98	Ø.337	Ø.323	Ø.112	Ø.134
1984	Ø.275	Ø.Ø83	Ø.267	Ø.117	Ø.127	Ø.175
1985	Ø.3Ø4	Ø.Ø15	Ø.224	Ø.Ø85	Ø.185	Ø.26Ø
1986	Ø.226	Ø.Ø35	Ø.289	Ø.1Ø3	Ø.148	Ø.156
1987	Ø.2Ø2	Ø.Ø52	Ø.281	Ø.157	Ø.159	Ø.Ø72

CASH FLOW / SALES

	COMPANY					
YEAR	1	2	3	4	5	6
1978	0.099	0.077	0.015	0.029	0.054	0.060
1979	0.093	0.079	0.070	0.029	0.052	0.074
1980	0.101	0.086	0.066	0.031	0.040	0.070
1981	0.108	0.078	0.049	0.023	0.043	0.045
1982	0.106	0.071	0.048	0.058	0.053	0.002
1983	0.092	0.065	0.064	0.065	0.060	0.031
1984	0.088	0.111	0.073	0.060	0.072	0.045
1985	0.009	0.070	0.073	0.047	0.068	0.042
1986	0.082	0.069	0.023	0.047	0.062	0.007
1987	0.078	0.064	0.081	0.039	0.063	0.057

	COMPANY					
YEAR	7	8	9	10	11	12
1978	0.071	0.058	0.116	0.125	0.055	0.050
1979	0.080	0.063	0.121	0.162	0.055	0.058
1980	0.046	0.063	0.127	0.144	0.052	0.054
1981	0.058	0.066	0.134	0.155	0.056	0.053
1982	0.060	0.070	0.124	0.126	0.057	0.048
1983	0.071	0.077	0.109	0.137	0.062	0.038
1984	0.080	0.086	0.123	0.195	0.067	0.045
1985	0.065	0.092	0.114	0.202	0.071	0.036
1986	0.072	0.095	0.090	0.107	0.034	0.046
1987	0.075	0.102	0.090	0.148	0.065	0.072

LONG TERM LIABILITY / SHAREHOLDER EQUITY

	COMPANY					
YEAR	1	2	3	4	5	6
1978	0.580	0.056	0.075	0.812	0.063	0.071
1979	0.545	0.039	0.057	0.700	0.063	0.047
1980	0.358	0.028	0.041	0.498	0.050	0.035
1981	0.275	0.097	0.018	0.758	0.043	0.025
1982	0.160	0.085	0.015	0.287	0.039	0.026
1983	0.334	0.076	0.011	0.090	0.029	0.016
1984	0.366	0.068	0.009	0.311	0.017	0.010
1985	0.255	0.003	0.011	0.345	0.229	0.005
1986	0.388	0.051	0.230	0.458	0.267	0.004
1987	0.425	0.049	0.171	0.674	0.259	0.003

	COMPANY					
YEAR	7	8	9	10	11	12
1978	0.690	0.323	0.452	0.279	0.388	0.718
1979	0.552	0.259	0.373	0.177	0.305	0.545
1980	0.482	0.194	0.372	0.404	0.265	0.449
1981	0.399	0.141	0.264	0.316	0.219	0.381
1982	0.335	0.101	0.198	0.250	0.231	0.449
1983	0.258	0.076	0.195	0.197	0.194	0.382
1984	0.200	0.078	0.240	0.788	0.237	0.336
1985	0.172	0.192	0.299	0.396	0.252	0.272
1986	0.253	0.171	0.350	0.326	0.363	0.394
1987	0.264	0.191	0.330	0.256	0.344	0.180

TOTAL LIABILITY / SHAREHOLDER EQUITY

	COMPANY					
YEAR	1	2	3	4	5	6
1978	Ø.975	1.198	Ø.899	1.715	1.582	1.254
1979	1.264	1.371	Ø.7ØØ	1.742	1.453	1.Ø31
198Ø	Ø.837	1.175	Ø.68Ø	Ø.949	1.578	1.226
1981	Ø.716	1.Ø6Ø	Ø.555	1.177	1.639	1.183
1982	Ø.437	1.Ø57	Ø.627	Ø.748	1.54Ø	1.4Ø6
1983	Ø.9Ø2	Ø.884	Ø.483	Ø.514	1.317	1.436
1984	Ø.943	1.Ø39	Ø.485	Ø.897	1.642	1.437
1985	Ø.625	Ø.921	Ø.743	1.Ø7Ø	1.759	1.373
1986	1.Ø54	1.151	1.421	1.138	1.781	1.739
1987	1.154	1.395	1.Ø15	1.364	1.874	1.927

	COMPANY					
YEAR	7	8	9	1Ø	11	12
1978	1.399	1.467	Ø.937	Ø.661	1.Ø87	1.8Ø7
1979	1.392	1.48Ø	Ø.862	Ø.473	1.144	1.694
198Ø	Ø.855	1.367	Ø.717	Ø.665	1.238	1.662
1981	Ø.798	1.311	Ø.672	Ø.522	Ø.984	1.462
1982	Ø.699	1.124	Ø.511	Ø.423	Ø.99Ø	1.671
1983	Ø.731	1.Ø11	Ø.496	Ø.334	Ø.947	1.5Ø1
1984	Ø.67Ø	1.Ø88	Ø.624	1.Ø54	Ø.992	1.Ø98
1985	Ø.496	1.177	Ø.741	Ø.637	1.Ø56	Ø.831
1986	Ø.626	1.1Ø2	Ø.652	Ø.564	1.339	1.6Ø1
1987	Ø.7Ø7	1.193	Ø.75Ø	Ø.465	1.211	Ø.894

NET INCOME / INTEREST EXPENSE

COMPANY

YEAR	1	2	3	4	5	6
1978	1.750	41.935	-2.812	1.255	23.612	24.079
1979	1.718	66.500	18.309	0.738	18.478	31.304
1980	2.833	54.099	6.940	1.105	9.451	29.690
1981	3.053	16.538	3.496	0.374	2.530	6.387
1982	2.230	6.791	4.105	2.082	8.041	1.125
1983	1.883	8.452	11.794	7.175	27.490	6.582
1984	1.733	21.861	57.833	4.866	5.255	21.397
1985	-1.251	28.300	16.126	2.198	3.635	12.322
1986	2.037	24.630	-1.059	1.446	2.731	1.426
1987	1.782	17.778	8.475	0.420	2.432	1.865

COMPANY

YEAR	7	8	9	10	11	12
1978	1.514	3.675	2.710	15.685	5.128	2.822
1979	1.393	4.184	3.112	29.745	2.349	3.545
1980	0.463	5.582	3.063	15.987	1.509	4.179
1981	1.980	5.790	3.230	15.677	1.595	5.355
1982	2.620	5.149	2.829	8.253	1.483	5.491
1983	5.433	9.155	1.912	10.256	2.093	1.890
1984	6.242	10.133	2.623	14.322	2.503	4.019
1985	4.262	6.499	1.918	21.015	2.512	5.563
1986	4.525	6.314	0.806	11.624	0.170	1.159
1987	4.043	7.065	0.517	23.284	1.716	1.391

CASH FLOW / INTEREST EXPENSE

COMPANY

YEAR	1	2	3	4	5	6
1978	4.705	54.364	2.797	2.397	32.459	29.672
1979	3.921	83.987	28.208	1.590	25.629	40.509
1980	5.490	72.658	11.132	1.930	15.961	40.172
1981	6.096	26.717	6.946	0.820	4.562	11.973
1982	5.361	14.930	7.621	2.663	14.524	1.125
1983	3.841	17.143	18.864	9.384	48.620	6.582
1984	3.377	32.000	86.530	6.871	11.184	21.397
1985	0.372	47.600	25.762	3.822	8.155	12.322
1986	3.276	41.778	3.511	2.943	7.730	1.426
1987	2.983	36.444	14.686	2.029	6.470	6.834

COMPANY

YEAR	7	8	9	10	11	12
1978	2.247	5.780	4.601	19.298	7.550	3.958
1979	2.029	6.199	4.739	35.135	3.561	4.736
1980	1.205	8.606	4.570	19.653	2.482	5.431
1981	3.288	9.171	4.768	19.129	2.654	6.893
1982	4.486	8.062	4.850	11.424	2.695	7.534
1983	7.647	14.631	4.295	13.697	3.740	3.086
1984	8.481	16.286	5.064	16.980	4.269	5.986
1985	7.183	11.392	3.755	25.319	4.175	11.458
1986	8.070	12.080	2.303	16.878	1.872	4.902
1987	7.373	13.729	1.830	29.290	3.252	3.359

NET INCOME / SALES

	COMPANY					
YEAR	1	2	3	4	5	6
1978	Ø.Ø37	Ø.Ø59	-Ø.Ø15	Ø.Ø15	Ø.Ø39	Ø.Ø48
1979	Ø.Ø41	Ø.Ø62	Ø.Ø46	Ø.Ø13	Ø.Ø38	Ø.Ø57
1980	Ø.Ø52	Ø.Ø64	Ø.Ø41	Ø.Ø18	Ø.Ø24	Ø.Ø52
1981	Ø.Ø54	Ø.Ø48	Ø.Ø25	Ø.Ø11	Ø.Ø24	Ø.Ø24
1982	Ø.Ø44	Ø.Ø32	Ø.Ø26	Ø.Ø45	Ø.Ø29	Ø.ØØ2
1983	Ø.Ø45	Ø.Ø32	Ø.Ø4Ø	Ø.Ø5Ø	Ø.Ø34	Ø.Ø31
1984	Ø.Ø45	Ø.Ø76	Ø.Ø49	Ø.Ø42	Ø.Ø34	Ø.Ø45
1985	-Ø.Ø31	Ø.Ø42	Ø.Ø46	Ø.Ø27	Ø.Ø3Ø	Ø.Ø42
1986	Ø.Ø51	Ø.Ø41	-Ø.ØØ7	Ø.Ø23	Ø.Ø22	Ø.ØØ7
1987	Ø.Ø46	Ø.Ø31	Ø.Ø47	Ø.ØØ8	Ø.Ø24	Ø.Ø16

	COMPANY					
YEAR	7	8	9	1Ø	11	12
1978	Ø.Ø48	Ø.Ø37	Ø.Ø68	Ø.1Ø2	Ø.Ø37	Ø.Ø36
1979	Ø.Ø55	Ø.Ø42	Ø.Ø8Ø	Ø.137	Ø.Ø36	Ø.Ø44
1980	Ø.Ø18	Ø.Ø41	Ø.Ø85	Ø.117	Ø.Ø32	Ø.Ø41
1981	Ø.Ø35	Ø.Ø41	Ø.Ø91	Ø.127	Ø.Ø33	Ø.Ø41
1982	Ø.Ø35	Ø.Ø45	Ø.Ø72	Ø.Ø91	Ø.Ø31	Ø.Ø35
1983	Ø.Ø5Ø	Ø.Ø48	Ø.Ø49	Ø.1Ø2	Ø.Ø35	Ø.Ø23
1984	Ø.Ø59	Ø.Ø53	Ø.Ø64	Ø.164	Ø.Ø39	Ø.Ø31
1985	Ø.Ø38	Ø.Ø53	Ø.Ø58	Ø.168	Ø.Ø42	Ø.Ø18
1986	Ø.Ø41	Ø.Ø5Ø	Ø.Ø32	Ø.Ø74	Ø.ØØ3	Ø.Ø11
1987	Ø.Ø41	Ø.Ø52	Ø.Ø25	Ø.117	Ø.Ø34	Ø.Ø3Ø

NET INCOME / TOTAL ASSETS

COMPANY

YEAR	1	2	3	4	5	6
1978	0.037	0.090	-0.027	0.036	0.052	0.095
1979	0.042	0.103	0.092	0.025	0.059	0.091
1980	0.064	0.101	0.080	0.034	0.037	0.070
1981	0.065	0.068	0.053	0.019	0.040	0.038
1982	0.043	0.038	0.061	0.090	0.046	0.004
1983	0.059	0.048	0.101	0.102	0.057	0.063
1984	0.059	0.093	0.126	0.075	0.053	0.085
1985	-0.021	0.061	0.084	0.051	0.048	0.092
1986	0.054	0.060	-0.014	0.040	0.035	0.015
1987	0.050	0.038	0.087	0.012	0.037	0.030

COMPANY

YEAR	7	8	9	10	11	12
1978	0.080	0.059	0.080	0.160	0.057	0.058
1979	0.080	0.063	0.095	0.183	0.051	0.073
1980	0.032	0.063	0.100	0.135	0.054	0.073
1981	0.062	0.061	0.106	0.144	0.061	0.080
1982	0.057	0.068	0.070	0.080	0.053	0.064
1983	0.089	0.074	0.048	0.079	0.058	0.039
1984	0.106	0.085	0.061	0.206	0.065	0.050
1985	0.067	0.081	0.057	0.198	0.060	0.025
1986	0.074	0.079	0.032	0.087	0.004	0.007
1987	0.078	0.073	0.023	0.120	0.050	0.029

SALES / TOTAL ASSETS

	COMPANY					
YEAR	1	2	3	4	5	6
1978	1.012	1.529	1.802	2.399	1.333	1.965
1979	1.029	1.660	2.025	1.851	1.561	1.598
1980	1.216	1.589	1.947	1.908	1.556	1.342
1981	1.199	1.408	2.176	1.785	1.692	1.583
1982	0.983	1.190	2.332	2.005	1.586	1.828
1983	1.311	1.490	2.520	2.041	1.693	2.043
1984	1.311	1.220	2.583	1.770	1.561	1.885
1985	0.687	1.475	1.835	1.922	1.579	2.168
1986	1.047	1.476	1.953	1.752	1.600	2.078
1987	1.087	1.222	1.857	1.475	1.540	1.938

	COMPANY					
YEAR	7	8	9	10	11	12
1978	1.689	1.603	1.173	1.568	1.538	1.606
1979	1.459	1.496	1.193	1.335	1.409	1.670
1980	1.815	1.559	1.177	1.147	1.682	1.780
1981	1.759	1.464	1.171	1.129	1.809	1.928
1982	1.632	1.518	0.976	0.883	1.699	1.820
1983	1.765	1.548	0.992	0.773	1.682	1.646
1984	1.803	1.588	0.956	1.252	1.649	1.646
1985	1.753	1.546	0.979	1.177	1.424	1.420
1986	1.813	1.596	1.025	1.181	1.413	0.656
1987	1.896	1.387	0.923	1.026	1.439	0.990

COST OF GOODS SOLD / INVENTORY

COMPANY

YEAR	1	2	3	4	5	6
1978	7.545	9.066	13.056	6.158	2.144	7.464
1979	5.171	8.509	14.497	4.200	2.360	3.469
1980	6.363	3.780	11.891	3.691	2.128	3.376
1981	5.297	2.417	18.914	3.228	2.473	5.165
1982	6.740	1.634	35.153	3.849	2.427	9.218
1983	5.992	2.731	32.021	4.212	3.435	8.688
1984	5.661	2.293	32.438	4.948	2.941	6.860
1985	3.161	4.409	12.710	4.942	2.979	9.884
1986	3.567	4.472	19.287	5.341	3.057	9.410
1987	4.156	3.717	20.967	3.944	2.731	8.196

COMPANY

YEAR	7	8	9	10	11	12
1978	2.450	4.741	1.859	10.453	3.689	3.951
1979	2.774	4.455	1.788	11.829	2.721	4.128
1980	2.784	4.640	1.720	12.252	3.162	4.344
1981	3.417	5.192	1.817	13.862	3.579	4.360
1982	3.893	6.124	1.792	15.866	3.352	4.814
1983	4.131	7.801	1.877	13.120	3.464	5.559
1984	3.910	8.103	1.829	19.444	3.328	5.139
1985	4.335	6.967	1.951	14.042	3.090	4.753
1986	3.423	7.194	2.030	11.538	3.296	4.552
1987	3.949	6.173	1.879	9.686	3.050	4.410

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Abstract

The purpose of this study was to develop and analyze financial ratio benchmarks of the aerospace defense contracting industry. The study addressed four questions: (1) How should the aerospace defense industry be specifically defined? (2) Which financial ratio benchmarks should be provided? What information does a specific ratio provide? (3) How are specific ratio benchmarks calculated and tested for statistical significance? (4) What problems result from financial ratio analysis?

Review of the literature disclosed the capability of defining a specific industry using the Standard Industry Classification System. An industry can be further restricted by only including companies that have recently contracted with the Department of Defense. Based on these restrictions the Compustat data bank was used to access sample data.

From an extensive list of ratios, 14 were selected from 7 main categories: (1) Cash Position, (2) Liquidity, (3) Working Capital/Cash Flow, (4) Capital Structure, (5) Debt Service Coverage, (6) Profitability, and (7) Turnover.

The basic benchmark measurement was defined as the median of the sample observations. Additionally, the central quartile was selected as the measurement of a reasonable range. Assuming the sample is/was representative of the industry, these measurements provided basic guidelines for all but one of the 14 ratios. The ratio WC/Sales displayed a trend which signified a potential need for adjustment.

Of the problems associated with ratio analysis, the most predominant constraint involves the use of alternative inventory valuation methods. However, prior studies found minimal consequences to company ranking resulted from these inconsistent methods. Still, ratio analysis does not provide a specific guide to action and its usefulness is dependent on the users ability to interpret its meaning.